# OREGON CULVERT FISH PASSAGE SURVEY



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Western Federal Lands Highway Division, Federal Highway Administration

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## ABSTRACT

This report presents the findings from a fish passage survey conducted on various types of highway culverts. The survey includes 39 culverts located throughout the state of Oregon. To simplify the findings, the report places the 39 Oregon culverts into four categories: (1) pipes and pipe-arches with no special provisions for fish passage, (2) pipes and pipe-arches with special provisions for fish passage, (3) pipes and pipe-arches with natural stream beds, and (4) arches. Based upon the survey, the report concludes that culverts with natural stream bed surfaces provide the best facilities for passing fish. The report, also, presents procedures and criteria for designing and installing highway culverts that must pass fish. From the presented survey findings and the recommended design and installation methods contained in the report, the reader should, therefore, be able to resolve most problems associated with designing and installing highway culverts to pass fish.

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# TABLE OF CONTENTS

| TOP 10 | 2                                |         |          |          |          |          |     |      |      |      |     |     |     |            |    |    |   |   |   |   |   |   |   |   |   |   |   | PAGE                 |
|--------|----------------------------------|---------|----------|----------|----------|----------|-----|------|------|------|-----|-----|-----|------------|----|----|---|---|---|---|---|---|---|---|---|---|---|----------------------|
| INTRO  | DUCTI                            | ON      |          |          | •        |          |     |      | ٠    |      |     | •   |     |            | •  | •  |   |   | • | ٠ | • |   | • |   | • | • |   | 1                    |
| EVAL   | JATION<br>ODFW<br>WFLHD<br>Desig | Cr<br>C | it       | er<br>te | ia<br>ri | a        | •   | •    | •    | •    | •   | •   | •   | •          | •  | •  | • | • | • | • | • | • | • | • | • | : | : | 2<br>7<br>8<br>12    |
| RESUL  | TS.                              | •       |          | •        | •        | •        |     | •    |      | •    | •   | •   | •   |            | •  |    |   |   | • |   |   |   |   | • | • | • | • | 16                   |
| CONCL  | USION                            | IS      |          |          |          | •        |     |      |      |      | •   |     |     |            | •  | •  |   |   |   |   | • | • | • | • |   |   |   | 30                   |
| RECOM  | MENDA<br>Desig<br>Desig<br>Insta | n<br>n  | Pr<br>Cr | oc<br>it | ed<br>er | ur<br>ia | es  | •    | :    | :    | :   | •   | •   | •          | •  | :  | : | • | • | • | • | : | • | • | • | : | • | 31<br>31<br>32<br>34 |
| REFER  | RENCES                           |         |          |          |          | •        | •   | •    | •    | •    |     |     |     |            |    | •  | • |   | • | • | • | • |   |   | • |   | • | 38                   |
| APPEN  | NDIX A                           |         | ΊE       | LD       | D        | ΑT       | Α   | CH   | łEC  | κı   | .19 | ŝΤ  |     |            |    |    |   | • |   |   |   |   |   |   |   |   | • | A-1                  |
| APPEN  | NDIX B                           |         | 10       | N        | F0       | RM       | ıs  |      |      |      | •   |     |     |            |    |    |   |   | • |   |   |   |   |   | • |   |   | B <b>-1</b>          |
| APPEN  | NDIX C                           |         | НҮ       | 'DR      | OL.      | .00      | Υ   |      |      |      |     |     |     |            |    |    |   |   |   |   |   |   |   |   |   | • |   | C <b>-</b> 1         |
| APPEN  | NDIX D<br>STREA                  |         | СН       | IAN      | INE      | L        | н   | /DF  | RAU  | JL ] | CS  | 5   |     |            |    |    |   |   |   |   |   |   |   |   |   |   |   | D-1                  |
| APPEN  | NDIX E                           |         | . D      | ES       | IG       | iN       | Sł  | 1E E | ET\$ | ò    |     |     |     | •          |    |    |   |   |   |   |   |   |   | • |   |   |   | £-1                  |
| APPE   | NDIX F<br>STREA                  |         | BE       | D        | MΑ       | TE       | R   | [Al  | . 0  | ìR/  | AD/ | AT) | 101 | <b>V</b> [ | )A | ГΑ |   |   |   |   |   |   |   |   |   |   |   | F-ì                  |
| APPEN  | NDIX G                           | •       | SC       | :011     | 'R       | A۱       | IAI | .γς  | SIS  | :    |     |     |     |            |    |    |   |   |   |   |   |   |   |   |   |   |   | G-1                  |

# LIST OF TABLES

|    |  | Page |
|----|--|------|
| 1. | Summary of Evaluations for Arches  | 17   |
| 2. | Summary of Evaluations for Pipes and Pipe-Arches with Natural Stream Beds                  | 17   |
| 3. | Summary of Evaluations for Pipes and Pipe-Arches with Special Features                     | 18   |
| 4. | Summary of Evaluations for Pipes and Pipe-Arches with No Special Features                  | 18   |
| 5. | Summary of Primary Hydraulic Parameters for Arches   | 19   |
| 6. | Summary of Primary Hydraulic Parameters for Pipes and Pipe-Arches with Natural Stream Beds | 20   |
| 7. | Summary of Primary Hydraulic Parameters for Pipes and Pipe-Arches with Special Features    | 21   |
| 8. | Summary of Primary Hydraulic Parameters for Pipes and Pipe-Arches with No Special Features | 21   |
| 9. | Fish Speeds of Average Size Adult Salmon and Steelhead Trout, as Reported by Bell (1973)   | 24   |
|    | LIST OF FIGURES  |      |
|    |  | Page |
| 1. | Four Classes of Culverts   | 3    |
| 2. | Location Map   | 6    |
| 3. | Swimming Performance of Salmon and Trout From Evans and Johnston (1980)                    | 24   |
| 4. | Headwater to Rise Ratio Versus Fish Passage Capability                                     | 25   |
| 5. | Culvert Barrel Velocity to Stream Channel Velocity Ratio Versus Fish Passage Capability    | 26   |
| 6. | Computed Outlet Scour Versus Fish Passage Capability                                       | 27   |
| 7. | Foundation Condition Versus Fish Passage Capability  | 28   |
| 8. | Computed Outlet Scour Versus Observed Scour  | 29   |

# LIST OF SYMBOLS AND DIMENSIONS

| Q2         | Two year flood, in cubic feet per second (cfs)  |
|------------|---|
| Q50        | Fifty year flood, in cubic feet per second (cfs)  |
| Vch        | Natural channel velocity, in feet per second (fps)  |
| Vb         | Culvert barrel velocity, in feet per second (fps)   |
| НЖ         | Headwater at culvert inlet, in feet (ft)  |
| R          | Rise of culvert, in feet (ft)   |
| Nch        | Manning's roughness value for the natural channel   |
| Nb         | Manning's roughness value for the culvert barrel  |
| <b>S</b> . | Stream channel slope, in feet per foot (ft/ft)  |
| D50        | Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft) |
| D          | Pipe diameter or rise, in feet (ft)   |
| Ke         | Culvert inlet loss coefficient  |
| Н          | Energy head for culvert flowing full, in feet (ft)  |
| dc         | Critical depth, in feet (ft)  |
| TW         | Culvert tailwater, in feet (ft)   |
| ho         | Height of hydraulic grade line above outlet invert, in feet (ft)  |
| L          | Culvert barrel length, in feet (ft)   |
| So         | Culvert barrel slope, in feet (ft)  |
| VO         | Culvert outlet velocity, in feet per second (fps)   |
| MO         | Width of culvert outlet, in feet (ft)   |
| Α          | Flow area at the culvert outlet, in square feet $(ft^2)$ , or culvert drainage area in square miles     |
| YΕ         | Equivalent depth at the culvert outlet, in feet (ft)  |
| FR         | Froude number   |

# LIST OF SYMBOLS AND DIMENSIONS (Continued)

| HS | Scour depth at culvert outlet, in feet (ft)        |
|----|--|
| Р  | Mean annual precipitation, in inches               |
| F  | Percent of basin forest                            |
| I  | Precipitation intensity, in inches                 |
| ST | Area of lakes and ponds, in percent                |
| TI | Mean basin January minimum temperature, in degrees |
| L  | Length of channel, in miles                        |

### INTRODUCTION

In the autumn of 1987, the Western Federal Lands Highway Division (WFLHD) conducted a fish passage study of 39 stream culverts located in the state of Oregon. WFLHD had two primary goals in conducting the fish passage study. The first goal was to determine which type of culvert facilities provided the best fish passage. The second goal was to determine if current design practices would have identified these same culverts as providing the best fish passage facilities.

To meet these goals, WFLHD surveyed each site with a level and transit for topographic data, obtained stream bed gradations at each site, and obtained photographs of each culvert and its adjacent stream Concurrently, WFLHD sent questionnaires to Oregon Department of Fish and Wildlife (ODFW) personnel requesting them to evaluate the importance and capability of each culvert to pass fish. Once WFLHD obtained the field data and received the completed ODFW questionnaires, they performed a hydrologic and hydraulic analysis of each site using WFLHD culvert design procedures. From the WFLHD field data, the ODFW questionnaires, and the WFLHD culvert design analysis, WFLHD determined which culvert installations provided the best conditions for fish passage.

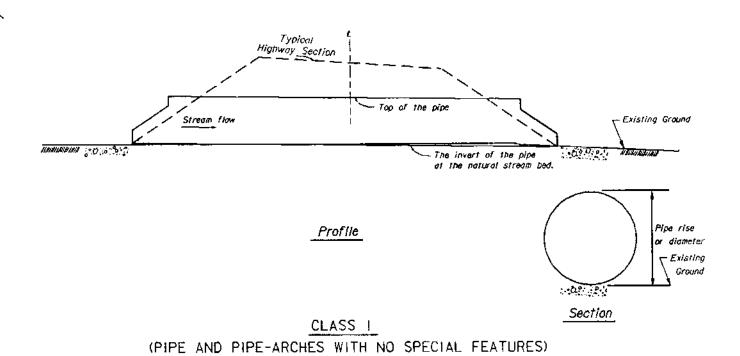
This report presents the detailed findings from the WFLHD study. In the process of presenting the findings, the report also provides an approach for designing culverts to pass fish. Hopefully, the presented findings and design procedures will resolve some of the current disagreements and problems associated with providing fish passage at stream culverts.

# **EVALUATION PROCEDURES**

As stated above, the study consisted of a WFLHD field survey, the ODFW questionnaires, and a WFLHD design analysis of the culvert's fish passage capability. For their study, WFLHD placed the existing culverts into four classes of fish passage facilities. The four classes included the following:

- 1. Pipes and pipe-arches with no special provisions for fish passage.
- Pipes and pipe-arches with special provisions for fish passage. The special provisions primarily include baffles and fish ladder systems.
- 3. Pipes and pipe-arches with natural stream beds. This culvert type includes pipes and pipe-arches with their inverts set below the natural stream bed slope. Normally, the installer of the culvert will cover the invert with native stream bed material. Thus, the culvert will have a natural stream bed throughout its length.
- 4. Arches. The arch culvert typically consists of a half section of pipe with concrete or metal footings for foundation support. Since the footing system allows the culvert to span the stream channel width, the culvert will have a natural stream bed throughout its length like the culverts just described in Class 3.

Examples of these four classes are illustrated in Figure 1.



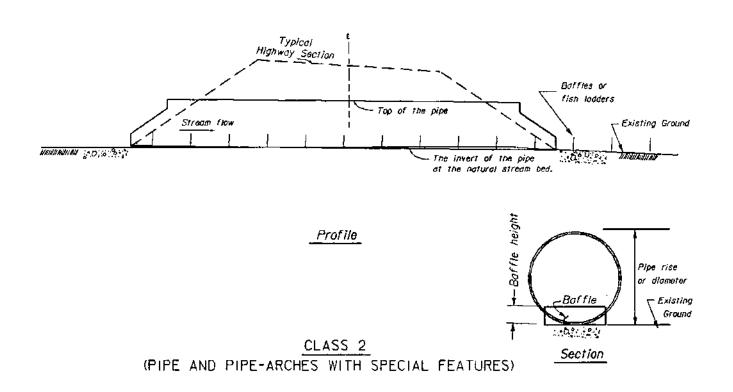
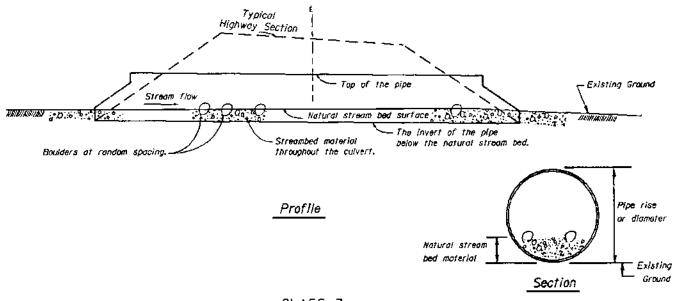


FIGURE 1. FOUR CLASSES OF CULVERTS



CLASS 3 (PIPE AND PIPE-ARCHES WITH NATURAL STREAM BEDS)

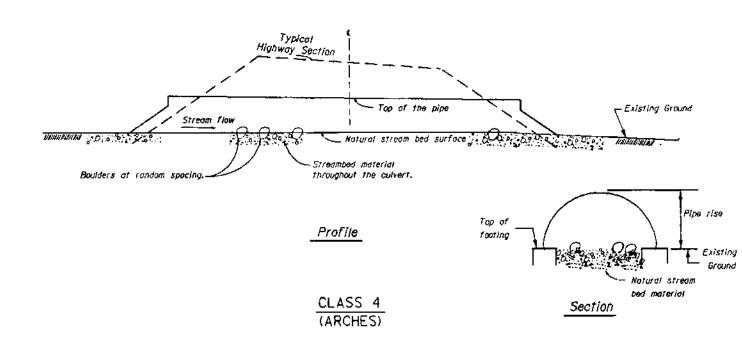


FIGURE I. FOUR CLASSES OF CULVERTS (CONTINUED)

WFLHD contacted each of the 23 ODFW District Fishery Biologists for a list of culverts that fit the above classes. However, WFLHD emphasized the culverts with a natural stream bed as the primary target of its study.

From the responses of the ODFW District Fishery Biologists, WFLHD targeted 65 culverts for the survey. Due to funding and time constraints, WFLHD reduced the number of culverts for their study to 48. After completing the field survey of the 48 culverts, WFLHD sent about 40 questionnaires to the respective fishery biologists for an evaluation of each culvert's passage capability.

Based upon the WFLHD data and the ODFW questionnaires, WFLHD compiled a final list of stream culverts for fish passage analysis. The list included six culverts with no special features for fish passage, six culverts with special features for fish passage, nine pipe and pipe-arches with natural stream beds, and 18 open bottom arches. Thus, the final list included a total of 39 stream culverts. Figure 2 shows the approximate locations of these 39 culverts.

For the 39 culverts, WFLHD collected field data that included the natural stream cross sections, the culvert dimensions and cross sections, the culvert types, and the types and dimensions of special features such as baffles and fish ladders. WFLHD also collected data on the locations and dimensions of culvert outlet scour and the locations and dimensions of any natural or manmade appurtenances such as log jams, adjacent culverts, and adjacent streams that may influence fish passage at the culvert site. Finally, they collected data on the gradation of the stream bed material and took

LOCATION MAP

representative photographs of the culvert and its surrounding stream environment. Appendix A contains the checklist for obtaining the WFHLD survey data.

# ODFW Criteria

To complement the WFLHD field data, the ODFW District Fishery Biologists rated each selected culvert site for its respective fish passage capabilities. WFLHD asked the ODFW personnel to provide the following information for each culvert site:

- 1. Type and condition of species. For example, many of the culvert locations support coho salmon, winter steelhead, and resident trout. Also, some of the culvert locations were important to the development of juvenile fish as well as the passage of adult fish.
- Importance of installation to subject species. The ODFW personnel rated each location as either critical, moderate, or noncritical to the local or migratory fishery.
- Evaluation of installation. The ODFW personnel rated each location as either good, fair, or poor in its capability to pass fish.

In addition, the ODFW provided comments related to specific aspects of the culvert (i.e., "large drop at the outlet is an obstruction to upstream migration"). Appendix B contains the forms with the completed ODFW evaluations.

# WFLHD Criteria

Using the field survey and the ODFW information, WFLHD analyzed and rated each culvert for its overall physical condition and its compatibility with the local stream environment. WFLHD used seven criteria. These criteria include the culvert condition, the culvert capacity, type of culvert foundation, condition of foundation, outlet scour, culvert stream bed surface, and the culvert hydraulics versus natural stream hydraulics. The culvert evaluation criteria were treated as follows:

- 1. Culvert condition. Based upon their field observations, WFLHD rated the overall physical condition of the culvert as either good, fair, or poor. If the culvert did not exhibit signs of roadway overtopping, foundation scour, barrel buckling, inlet or outlet damage, or any other defects that would make the culvert unserviceable, then they rated the culvert as good. If the culvert exhibited one of these defects, then they rated the culvert as fair. If the culvert exhibited more than one defect or if one defect was so severe that the culvert was highly susceptible to failure (i.e., excessive foundation scour), then they rated the culvert as poor. In general, this rating shows the culvert's ability to service the transportation system it serves.
- 2. Culvert capacity. Using the 50-year flood frequency, WFLHD determined the inlet headwater to pipe diameter ratio for each culvert. If the culvert was not circular, then they substituted the culvert rise for the pipe diameter. If the HW/R ratio was less than or equal to 1.0, they rated the culvert as good. If the HW/R ratio was greater than 1.0 but

less than or equal to 1.5, they rated the culvert as fair. For ratios greater than 1.5, they rated the culvert as poor. In general, this rating shows the chance of roadway overtopping during a major flood event. This rating also indirectly shows the constriction of the culvert upon the natural stream flow (i.e., HW/R ratio greater than 1.0). If a culvert constricts the natural channel too much, it may induce high inlet velocities that impede the passage of fish.

- 3. Type of culvert foundation. Footings or surrounding materials in the form of a closed loop (i.e., ring compression) normally support the culvert. WFLHD found the culverts in the study to be either "open" or "closed." They further found that either concrete or metal footings supported the open or arch culverts. They used this information in the evaluation of the other criteria.
- 4. Condition of foundation. Based upon their field observations, WFLHD rated the condition of the culvert foundation as good, fair, or poor. For a closed culvert, they rated the culvert as good if there was little evidence or chance that the culvert would settle or collapse. In this case, the culvert had good foundation materials and the adjacent stream flow was not likely to remove these materials. For an arch or open culvert, if nonerosive material supported the footings (i.e., bedrock), then they rated the culvert foundation as good. If the installer located the footings a reasonable distance below the expected scour depth, then they also rated the culvert foundation as good.

For both the closed and open culverts, WFLHD rated the foundations as fair if there was a chance of foundation failure during a major flood event or the culvert already exhibited slight signs of foundation failure. If the culvert foundation had already exhibited significant settlement, then they rated the foundation as poor. Also, if the footings exhibited either signs of undermining due to stream flow or were highly susceptible to scour failure during a minor to major flood event, then they rated the foundation as poor. In general, if they rated the culvert foundation as poor, this could significantly lower the rating of the culvert's overall condition.

5. Outlet scour. Based upon their field observations, WFLHD rated the culvert outlet scour condition as either severe, moderate, or negligible. If the scour depth was 1.5 feet or greater, they rated the outlet scour as severe. If the scour depth was less than 1.5 feet but greater than 0.5 feet, they rated the culvert outlet scour as moderate. If the scour depth was less than or equal to 0.5 feet, they rated the culvert outlet scour as negligible. WFLHD measured the scour depth at the culvert locations during low flow periods. Therefore, the actual outlet scour depths during flood events is probably much greater.

In general, this criteria shows whether or not a significant difference in elevation will develop between the culvert end and the natural stream bed located just downstream. The reader should not confuse this item with natural lowering of the stream bed over time and space (i.e., degradation). Nor should the reader confuse this item with the scour of

natural stream bed materials that may occur within the culvert barrel due to flood events.

- 6. Culvert stream bed surface. The stream bed surface at a culvert normally consists of the culvert barrel material (i.e., metal or concrete) or natural stream bed materials. The term natural stream bed materials includes materials native to the area or any other materials that would provide flow or sediment characteristics native to the area (i.e., clays, silts, sands, gravel, cobbles, boulders). This item is important for determining the barrel velocities and the scour potential within the culvert area. In general, a natural stream bed surface should generate hydraulic and sedimentation conditions compatible with the natural stream environment.
- 7. Culvert hydraulics versus natural stream hydraulics. Using the 2-year flood and the 50-year flood, WFLHD computed the culvert barrel depths and velocities and the natural stream depths and velocities. If the barrel velocities did not exceed the natural stream velocities by more than 50 percent, they rated the culvert as being compatible. Otherwise, they rated the culvert as incompatible with the natural stream environment. In addition to the velocity criteria, they also subjectively considered the constriction of the culvert barrel and the culvert outlet scour in the compatibility rating.

Finally, WFLHD provided general comments related to specific aspects of the culvert installation (i.e., "the short culvert length permits fish to pass

upstream through the barrel despite high velocities"). These comments are included in Appendix B.

# Design Analysis

To complete the final portion of the study, WFLHD used their design procedures for analyzing the hydrologic and hydraulic characteristics of each culvert. The following is a brief outline of the main steps in their analytical approach:

- 1. WFLHD determined the 2-year and 50-year flood values for each of the culvert sites. WFLHD typically uses the 2-year flood for checking the fish passage characteristics of the culvert. For the culvert's serviceability to the transportation system, they normally use the 50-year flood to check for roadway overtopping and inlet and outlet erosion. Since they found only one culvert site located near a gaging station, WFLHD used USGS regression equations to determine the flood peaks for each culvert (1)(2). Appendix C contains the hydrologic inputs and the computed values for the 2-, 5-, 10-, 25-, 50-, and 100-year flood for each culvert.
- Using the computed flood values and the topographic data obtained from the field survey, WFLHD computed the depth and velocity values for a typical channel section at each culvert location. For the hydraulic analysis, they used Manning's equation for uniform flow to determine the depth and velocity values (3). Specifically, they used three primary

inputs: first, a trapezoidal section to define the irregular stream cross section; second, an energy slope based upon the average stream bed slope within the vicinity of the culvert; and third, a roughness value based upon the local stream bed materials (3).

Appendix D contains the hydraulic inputs and the computed depths and velocities for the 2- and 50-year flood for each culvert. For informational purposes, Appendix D also contains the computed stream bed shear stress and the computed particle diameter that the stream can transport. For both of these values, WFLHD used the tractive force and permissible shear stress methods (3)(4).

3. Once WFLHD determined the natural stream hydraulics for each culvert location, they analyzed the hydraulics of each culvert. WFLHD specifically computed the culvert headwater to pipe rise ratio, the culvert barrel velocity, and the culvert outlet velocity. They derived these output values using the typical culvert cross-section area, the culvert bed roughness, the culvert inlet configuration, the culvert bed slope, and downstream influences (i.e., log barriers, adjacent streams).

WFLHD computed the headwater to pipe rise ratio and the culvert outlet velocity using standard culvert design methods (i.e., inlet control, outlet control). FHWA publication "Hydraulic Design Series No. 5" contains the appropriate design methods (5). For the culvert barrel velocity, WFLHD normally computed this value using the same Manning's equation described above under Item 2. Of course, they substituted the culvert cross section, the culvert slope, and the culvert bed

roughness for the natural stream characteristics. Appendix E contains the culvert design sheets for each location. These sheets contain the above input and output values for the 2-year and 50-year floods.

4. After they completed the culvert hydraulics, WFLHD computed the outlet scour using the methods contained in FHWA publication "Hydraulic Engineering Circular No. 14" (6). The circular presents a method in chapter V for computing the outlet scour for clay size to fine gravel sized particles. Appendix F contains the stream bed gradations for each culvert site included in the WFLHD study. Appendix F shows the stream bed gradations to range from fine gravel to coarse gravel. For this reason, WFLHD used the method contained in chapter XI of Circular No. 14 to compute the outlet scour. They used this information to determine whether or not the field survey should have shown scour at the culvert outlet.

Appendix G contains the input values and the corresponding computed scour depths for the 2-year and 50-year floods. Although WFLHD used both methods from Circular No. 14 to check for outlet scour, Appendix G contains only the results from the method presented in chapter XI. Specifically, WFLHD input the design discharge, the culvert outlet velocity, the culvert width, the stream bed particle size, and the tailwater depth at the culvert outlet. For the stream bed particle size,

they normally used the particle size of the gradation of such that 50 percent of the mixture is finer by weight. For the tailwater depth, they normally used the computed downstream channel depth from Manning's equation unless field conditions indicated other downstream controls (i.e., log weirs, flood waters from adjacent streams).

5. Finally, WFLHD compared stream channel velocities, culvert barrel velocities, and the stream bed material gradations to the maximum permissible velocities that will not cause erosion of the channel body. For their study, WFLHD used the Fortier and Scobey maximum permissible velocity values (3). They used this information primarily for rating the foundation condition of arches. For example, if the culvert footings were only 1 to 2 feet below the stream bed and the culvert velocities exceeded the maximum permissible velocities, then they rated the foundation condition lower than otherwise. However, they did not compute scour depths within the culvert because of insufficient information on the sediment transporting capability of each stream. Therefore, WFLHD used this parameter as a guide in their subjective evaluation of the foundation condition of arches.

### RESULTS

Tables 1, 2, 3, and 4 summarize the WFLHD and ODFW evaluations for the fish passage study. Tables 5, 6, 7, and 8 summarize the primary hydraulic parameters used in the WFLHD evaluations. Based upon a review of these tables, WFLHD presents the following summary of the results:

- 1. ODFW personnel rated the arch as a good facility for passing fish (Table 1). ODFW personnel generally rated the pipes and pipe-arches with natural stream beds as good for fish passage (Table 2). The ODFW evaluators gave poor or fair ratings to the pipe and pipe-arches with special passage features (Table 3), while they gave mixed ratings to the pipes and pipe-arches with no special features (Table 4).
- WFLHD personnel generally gave good ratings for the overall physical condition, the culvert capacity, and the foundation condition to pipes and pipe-arches with and without special features. WFLHD personnel also gave good ratings to pipes and pipe-arches with natural stream beds for the same criteria. While they gave fair or good ratings for the hydraulic capacity of arches, the WFLHD personnel gave poor or fair ratings for the arches' overall physical and foundation conditions.
- 3. WFLHD personnel generally rated outlet scour as negligible for arches and culverts with natural stream beds. Conversely, their ratings on outlet scour ranged from negligible to severe for culverts with and without special features.

| TABLE 1. SUMMARY OF EVALUATIONS FOR ARCHES |         |      |      |           |          |            |            |               |            |  |  |  |  |
|--|---------|------|------|-----------|----------|------------|------------|---------------|------------|--|--|--|--|
|  |         | SPAN | RISE | OVERALL   | CULVERT  | FOUNDATION | OUTLET     | HYDRAULIC     | PASSAGE    |  |  |  |  |
| STREAM NAME                                | REF. NO | FT   | FT   | CONDITION | CAPACITY | CONDITION  | SCOUR      | COMPATIBILITY | CAPABILITY |  |  |  |  |
|  |         |      |      |           |          |            |            |               |            |  |  |  |  |
| Cool Creek                                 | 1-C     | 14.7 | 9.5  | Poor      | Fair     | Fair       | Negligible | Compatible    | Good       |  |  |  |  |
| Lost Creek                                 | 1-D     | 18.2 | 5.6  | Fair      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Little Looking                             |         |      |      |           |          |            |            |               |            |  |  |  |  |
| Glass Creek                                | 14-B    | 17.6 | 8.0  | Fair      | Good     | Poor       | Negligible | Incompatible  | Good       |  |  |  |  |
| Devil's Run                                |         |      |      |           |          |            |            |               |            |  |  |  |  |
| Creek                                      | D-6     | 10.2 | 4.5  | Fair      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Gumboot Creek                              | D-8     | 15.0 | 8.5  | Fair      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Elk Creek                                  | 15-D    | 13.9 | 6.1  | Fair      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Chesnimus Creek                            | 15-ξ    | 11.0 | 5.7  | Fair      | Fair     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Crow Creek                                 | 15-F    | 12.8 | 5.0  | Good      | Poor     | Good       | Negligible | Compatible    | Good       |  |  |  |  |
| Ruby Creek                                 | 12-0    | 8.0  | 4.0  | Good      | Fair     | Fair       | Negligible | Compatible    | Good       |  |  |  |  |
| Big Creek                                  | 12-E    | 12.0 | 7.0  | Poor      | Fair     | Poor       | Moderate   | Compatible    | Good       |  |  |  |  |
| Indian Creek                               | 12-F    | 12.0 | 7.0  | Poor      | Fair     | Poor       | Moderate   | Compatible    | Good       |  |  |  |  |
| Granite Creek                              | 12-G    | 12.8 | 5.3  | Fair.     | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Gramite Creek                              | 12-H    | 13.1 | 6.8  | Fair      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Granite Creek                              | 12-I    | 13.2 | 6.9  | Poor      | Good     | Poor       | Negligible | Compatible    | Good       |  |  |  |  |
| Marks Creek                                | 11-A    | 18.0 | 8.8  | Good      | Good     | Fair       | Negligible | Compatible    | Good       |  |  |  |  |
| Lowe Creek                                 | 2-A     | 21.7 | 11.7 | Fair      | Good     | Poor       | Moderate   | Compatible    | Good       |  |  |  |  |
| Haight Creek                               | 7-A     | 18.2 | 8,9  | Fair      | Good     | Fair       | Negligible | Compatible    | Good       |  |  |  |  |
| Eames Creek                                | 7-B     | 13.8 | 6.9  | Fair      | Fair     | Fair       | Negligible | Compatible    | Good       |  |  |  |  |

|                 | TABLE 2. | SUMMARY | OF EVA | LUATIONS FOR | PIPES AND | PIPE-ARCHES | WITH NATURAL S | TREAM BEDS    |            |
|-----------------|----------|---------|--------|--------------|-----------|-------------|----------------|---------------|------------|
|                 |          | SPAN    | RISE   | OVERALL      | CULVERT   | FOUNDATION  | OUTLET         | HYDRAULIC     | PASSAGE    |
| STREAM NAME     | REF. NO  | FT      | FI     | CONDITION    | CAPACITY  | CONDITION   | SCOUR          | COMPATIBILITY | CAPABILITY |
|                 |          |         |        |              |           |             |                |               |            |
| Newell Creek    | 1-B      |         | 14.0   | Good         | Good      | Good        | Negligible     | Compatible    | Good       |
| Meacham Creek   | 13-A     | 12.8    | 14.0   | Good         | Good      | Good        | Negligible     | Compatible    | Fair       |
| Meacham Creek   | 13-8     |         | 15.0   | Good         | Good      | Good        | Negligible     | Compatible    | Fair       |
| Meacham Creek   | 13-C     | 14.0    | 15.0   | Good         | Good      | Good        | Negligible     | Compatible    | Fair       |
| Meacham Creek   | 13-0     | 20.0    | 20.0   | Good         | Good      | Good        | Negligible     | Compatible    | Good       |
| Middle Fork of  |          |         |        |              |           |             |                |               |            |
| Canyon Creek    | 12-8     | 13.5    | 8.5    | Good         | Good      | Good        | · Negligible   | Compatible    | Good       |
| Canyon Creek    | 12-Ç     |         | 10.0   | Fair         | Good      | Good        | Negligible     | Compatible    | Good       |
| Sunflower Creek | 12-J     | 17.3    | 10.0   | Good         | Good      | Good        | Negligible     | Compat1ble    | Good       |
| Brown's Creek   | 10-A     | 12.6    | 9.4    | Good         | Good      | Good        | Negligible     | Compatible    | Good       |
|                 |          |         |        |              |           |             |                |               |            |

|              |          |           |           |               | . ,         |               |              |               |            |
|--------------|----------|-----------|-----------|---------------|-------------|---------------|--------------|---------------|------------|
|              | TABLE 3. | SUMMA     | RY OF     | EVALUATIONS F | OR PIPES AN | D PIPE-ARCHES | WITH SPECIAL | FEATURES      |            |
|              |          | SPAN      | RISE      | OVERALL       | CULVERT     | FOUNDATION    | OUTLET       | HYDRAULIC     | PASSAGE    |
| STREAM NAME  | REF. NO  | <u>FT</u> | <u>FT</u> | CONDITION     | CAPACITY    | CONDITION     | SCOUR        | COMPATIBILITY | CAPABILITY |
| Mt. Scott    |          |           |           |               |             |               |              |               |            |
| Creek        | 1-A      | 10.0      | 8.0       | Good          | Good        | Good          | Severe       | Incompatible  | Poor       |
| Mottet Creek | 14-A     | 5.8       | 7.0       | Good          | Fair        | Good          | Negligible   | Incompatible  | Fair       |
| Billy Creek  | C-3      | 6.3       | 5.0       | Good          | Good        | Good          | Negligible   | Incompatible  | Fair-Poor  |
| Camp Creek   | B-2      |           | 8.0       | Fair          | Poor        | Good          | Severe       | Compatible    | Fair       |
| Doe Creek    | C-4      | 7.7       | 5.4       | Good          | Good        | Good          | Negligible   | Incompatible  | Fair-Poor  |
| Poop Creek   | 2-B      |           | 4.0       | Good          | Good        | Good          | Moderate     | Incompatible  | Fair       |

|                 | TABLE 4. | SUMMARY | OF EVA | ALUATIONS FOR | PIPES AND | PIPE-ARCHES | WITH NO SPECIA | <u>L FEATURES</u> |            |
|-----------------|----------|---------|--------|---------------|-----------|-------------|----------------|-------------------|------------|
|                 |          | SPAN    | RISE   | OVERALL       | CULVERT   | FOUNDATION  | OUTLET '       | HYDRAULIC         | PASSAGE    |
| STREAM NAME     | REF. NO  | FT      | FT     | CONDITION     | CAPACITY  | CONDITION   | SCOUR          | COMPATIBILITY     | CAPABILITY |
|                 |          |         |        |               |           |             |                |                   |            |
| Polallie Creek  | C-7      | 12.7    | 7.25   | Good          | Fair      | Good        | Moderate       | Incompatible      | Good       |
| Tamarack Gulch  | 15-A     | 6.0     | 3.9    | Good          | Good      | Good        | Negligible     | Incompatible      | Good       |
| South Fork      |          |         |        |               |           |             |                |                   |            |
| Chesnimus Creek | 15-B     |         | 6.7    | Good          | Good      | Good        | Moderate       | Incompatible      | Fair       |
| Sheep Creek     | 13-€     |         | 7.0    | Good          | Good      | Good        | Negligible     | Incompatible      | Poor       |
| Canyon Creek    | 12-A     | 12.6    | 1.8    | Good          | Fair      | Good        | Severe         | Incompatible      | Fair       |
| Pine Creek      | 3-A      |         | 7.5    | Fair          | Fair      | Good        | Severe         | Incompatible      | Good       |

| TABLE 5. SUMMARY OF PRIMARY HYDRAULIC PARAMETERS FOR ARCHES |               |      |            |            |            |            |      |            |        |            |            |                                       |       |           |       |         |           |       |           |
|---|---------------|------|------------|------------|------------|------------|------|------------|--------|------------|------------|---------------------------------------|-------|-----------|-------|---------|-----------|-------|-----------|
|   |               |      |            |            |            |            |      | Q2         |        |            | Q50        | · · · · · · · · · · · · · · · · · · · |       |           |       |         |           | Q2    | Q50       |
|   |               | SPAN | RISE       | Q2         | <b>Q50</b> | Q50        | Vch  | ٧b         |        | Vch        | ٧b         |                                       |       |           |       | S       | D50       | Scour | Scour     |
| STREAM NAME   | REF. ND       | FT   | <u>_FT</u> | <u>cfs</u> | CFS        | HW/R       | FPS  | <u>FPS</u> | Vb/Vch | <u>FPS</u> | <u>FPS</u> | Vb/Vo                                 | h Nch | <u>Nb</u> | Nch/N | b FT/FT | <u>FT</u> | FT    | <u>FT</u> |
| Cool Creek  | 1-C           | 14.7 | 9.5        | 145        | 365        | 1.1        | 4.3  | 4.6        | 1.1    | 5.5        | 6.3        | 1.1                                   | .045  | .045      | 1.0   | .010    | . 17      | 0.0   | 0.0       |
| Lost Creek  | 1-D           | 18.2 | 5.6        | 255        | 650        | 0.8        | 5.3  | 5.8        | 1.1    | 7.0        | 8.2        | 1.2                                   | .045  | .045      | 1.0   | .014    | .06       | 0.0   | 0.0       |
| Little Looking<br>Glass Creek                               | 14-B          | 17.6 | 8.0        | 195        | 560        | 0.8        | 3.7  | 6.0        | 1.6    | 4.7        | 8.0        | 7.7                                   | .045  | .045      | 1.0   | .016    | .08       | 0.0   | 0.0       |
| Devil's Run   |               |      |            |            |            |            |      |            |        |            |            |                                       |       |           |       |         |           |       |           |
| Creek   | D-6           | 10.2 | 4.5        | 28         | 129        | 0.8        | 3.3  | 3.7        | 1.1    | 4.7        | 5.7        | 1.2                                   | .040  | .040      | 1.0   | .014    | .13       | 0.0   | 0.0       |
| Gumboot Creek   | D-8           | 15.0 | 8.5        | 142        | 444        | 0.6        | 4.4  | 5.8        | 1.3    | 5.9        | 8.2        | 1.4                                   | .045  | .045      | 1.0   | .017    | .21       | 0.0   | 0.0       |
| Elk Creek   | 15 <b>-</b> D | 13.9 | 6.1        | 71         | 333        | 0.8        | 3.5  | 3.9        | 1.7    | 5.7        | 6.0        | 1.1                                   | .045  | .045      | 1.0   | 010.    | .17       | 0.0   | 0.0       |
| Chesnimus Creek   | 15-E          | 11.0 | 5.7        | 91         | 381        | 1.3        | 3.5  | 1.8        | 0.5    | 5.0        | 7.6        | 1.5                                   | .040  | .040      | 1.0   | .001    | .12       | 0.0   | 0.0       |
| Crow Creek  | 15-F          | 12.8 | 5.0        | 135        | 603        | 2.1        | 5.0  | 5.4        | 1.1    | 7.4        | 10.2       | 1.3                                   | .040  | .040      | 1.0   | .012    | .04       | 0.0   | 2.1       |
| Ruby Creek  | 12-D          | 8.0  | 4.0        | 40         | 165        | 1.1        | 4.5  | 5.9        | 1.3    | 7.2        | 8.5        | 1.2                                   | .040  | .040      | 0.1   | .030    | .05       | 0.6   | 1.8       |
| Big Creek   | 12-E          | 12.0 | 7.0        | 230        | 725        | 1.5        | 8.3  | 8.01       | 1.3    | 12. F      | 14.7       | 1.2                                   | .040  | .040      | 1.0   | .044    | .19       | 3.9   | 7.7       |
| Indian Creek  | 12-F          | 12.0 | 7.0        | 185        | 590        | 1.2        | 7.7  | 9.6        | 1.2    | 10.8       | 13.1       | 1.2                                   | .040  | .040      | 1.0   | .034    | .15       | 2.8   | 5.8       |
| Granite Creek   | 12-G          | 12.8 | 5.3        | 75         | 290        | 8.0        | 4.8  | 4.9        | 1.0    | 8.8        | 7.2        | 1.1                                   | .040  | .040      | 1.0   | .012    | .13       | 0.0   | 0.0       |
| Granite Creek   | 12-H          | 13.1 | 6.8        | 75         | 290        | 0.6        | 4. ? | 4.7        | 1.1    | 6.2        | 7.1        | 1.1                                   | .045  | .045      | 1.0   | .015    | .25       | 0.0   | 0.0       |
| Granite Creek   | 12-I          | 13.2 | 6.9        | 95         | 350        | 0.5        | 6.4  | 6.2        | 1.0    | 9.0        | 9.0        | 1.0                                   | .045  | .045      | 1.0   | .022    | .17       | 0.0   | 1.2       |
| Marks Creek   | 11-A          | 18.0 | 8.8        | 115        | 600        | 0.8        | 3.6  | 3.0        | 0.8    | 5.6        | 4.8        | 0.9                                   | .040  | .040      | 1.0   | .003    | .06       | 0.0   | 0.0       |
| Lowe Creek  | 2-A           | 21.7 | 11.7       | 440        | 1160       | 0.7        | 9.7  | 10.5       | 1.1    | 12.1       | 14.7       | 1.2                                   | .045  | .045      | 1.0   | .050    | .13       | 2.8   | 7.2       |
| Haight Creek  | 7-A           | 18.2 | 8.9        | 190        | 440        | 0.7        | 3.1  | 3.1        | 1.0    | 4.0        | 3.7        | 0.9                                   | .040  | .035      | 1.1   | .002    | .06       | 0.0   | 0.0       |
| Eames Creek   | 7-B           | 13.8 | 6.9        | 280        | 640        | <u>1.1</u> | 3.9  | 4.0        | 1.0    | 5.0        | 7.4        | 1.5                                   | .040  | .035      | 1.1   | .002    |           |       |           |
| Averages  |               |      |            | 155        | 484        | 1.0        | 5.0  | 5.5        | 1.1    | 6.9        | 8.4        | 1.2                                   | .042  | .042      | 1.0   | .017    | .13       | 0.6   | 1.5       |

TABLE 6. SUMMARY OF PRIMARY HYDRAULIC PARAMETER FOR PIPES AND PIPE-ARCHES WITH NATURAL STREAM BEDS

|                 |               |      |           |            |            |            |            | . Q2 |        |            | Q50        |       | _     |           |       | -        |           | Q2    | Q50       |
|-----------------|---------------|------|-----------|------------|------------|------------|------------|------|--------|------------|------------|-------|-------|-----------|-------|----------|-----------|-------|-----------|
|                 |               | SPAN | RISE      | Q2         | Q50        | Q50        | Vch        | ۷ь   |        | Ych        | ٧ь         |       |       |           |       | S        | D50       | Scour | Scour     |
| STREAM NAME     | REF. NO       | FT   | <u>FT</u> | <u>CFS</u> | <u>CFS</u> | HW/R       | <u>FPS</u> | FPS  | Vb/Vch | <u>FPS</u> | <u>FPS</u> | Vb/Vc | h Nch | <u>Nb</u> | Nch/N | <u> </u> | <u>FT</u> | FT    | <u>FT</u> |
| Newell Creek    | 1-B           |      | 14.0      | 95         | 275        | 0.4        | 3.6        | 4.0  | 1.1    | 5.0        | 6.0        | 1.2   | .045  | .045      | 1.0   | .010     | 10.       | 0.0   | 0.0       |
| Meacham Creek   | 13-A          | 12.8 | 14.0      | 75         | 500        | 0.6        | 3.8        | 4.8  | 1.3    | 6.6        | 7.6        | 1.2   | .045  | .045      | 1.0   | .013     | .06       | 0.0   | 0.0       |
| Meacham Creek   | 13 <b>-</b> 8 |      | 15.0      | 95         | 625        | 0.6        | 4.3        | 5.2  | 1.2    | 7.3        | 8.0        | 1.1   | .045  | .045      | 0.1   | .013     | .08       | 0.0   | 0.0       |
| Meacham Creek   | 13-C          | 14.0 | 15.0      | 95         | 625        | 0.5        | 5.1        | 6.0  | 1.2    | 8.9        | 9.4        | 1.1   | .045  | .045      | 1.0   | .020     | .13       | 0.0   | 1.0       |
| Meacham Creek   | 13-D          | 20.0 | 20.0      | 95         | 625        | 0.5        | 4.9        | 5.3  | 1.1    | 8.4        | 8.7        | 1.0   | .045  | .045      | 1.0   | .014     | .13       | 0.0   | 0.9       |
| Middle Fork of  |               |      |           |            |            |            |            |      |        |            |            |       |       |           |       |          |           |       |           |
| Canyon Creek    | 12-B          | 13.5 | 8.5       | 110        | 350        | 0.8        | 4.4        | 6.2  | 1.4    | 5.9        | 8.6        | 1.5   | .045  | .045      | 1.0   | .022     | .05       | 0.0   | 0.6       |
| Canyon Creek    | 12-C          |      | 10.0      | 105        | 345        | 0.7        | 5.7        | 6.5  | 1.1    | 8.1        | 9.0        | 1.1   | .040  | .040      | 1.0   | .018     | .09       | 0.1   | 1.2       |
| Sunflower Creek | 12-J          | 17.3 | 10.0      | 135        | 485        | 0.6        | 4.9        | 7.0  | 1.4    | 7.4        | 10.8       | 1.5   | .045  | .045      | 1.0   | .037     | .21       | 0.3   | 3.0       |
| Brown's Creek   | 10-A          | 12.6 | 9.4       | 100        | 415        | <u>0.8</u> | 3.2        | 4.2  | 1.3    | 4.7        | 6.1        | 1.3   | .040  | .035      | 1.1   | .005     | .04       | 0.0   | 0.0       |
| Averages        |               |      |           | 101        | 472        | 0.6        | 4.4        | 5.5  | 1.2    | 6.9        | 8.2        | 1.2   | .044  | .043      | 1.0   | .017     | .09       | 0.0   | 0.7       |

| TABLE 7. SUMMARY OF PRIMARY HYDRAULIC PARAMETERS FOR PIPES AND PIPE-ARCHES WITH SPECIAL FEATURES |         |           |      |            |            |      |            |            |        |      |            |       |              |           |            |         |             |       |           |
|--|---------|-----------|------|------------|------------|------|------------|------------|--------|------|------------|-------|--------------|-----------|------------|---------|-------------|-------|-----------|
|  |         |           |      |            |            |      |            | Q2         |        |      | Q50        |       | _            |           |            |         |             | Q2    | Q50       |
|  |         | SPAN      | RISE | Q2         | Q50        | Q50  | Vch        | ٧ь         |        | Vch  | ٧b         |       |              |           |            | S       | D50         | Scour | Scour     |
| STREAM NAME  | REF. NO | <u>F7</u> | FT   | <u>CFS</u> | <u>CFS</u> | HW/R | <u>FPS</u> | <u>FPS</u> | Vb/Vch | FPS  | <u>FPS</u> | Vb/Vc | h <u>Nch</u> | <u>Nb</u> | Nch/N      | b FT/FI | FT          | FT    | <u>FT</u> |
|  |         |           |      |            |            |      |            |            |        |      |            |       |              |           |            |         |             |       |           |
| Mt. Scott Creek  | 1-A     | 10.0      | 8.0  | 110        | 330        | 0.7  | 4.7        | 11.0       | 2.3    | 6.6  | 15.0       | 2.3   | .045         | .015      | 3.0        | .017    | .06         | 4.3   | 8.0       |
| Mottet Creek   | 14-A    | 5.8       | 7.0  | 125        | 375        | 1.4  | 6.7        | 16.4       | 2.4    | 9.0  | 20.5       | 2.3   | .045         | .024      | 1.9        | .057    | .17         | 8.5   | 13.3      |
| Billy Creek  | C-3     | 6.3       | 5.0  | 45         | 197        | 0.8  | 4.5        | 8.0        | 1.8    | 6,5  | 11.7       | 1.8   | .040         | .024      | 1.7        | .023    | .08         | 0.0   | 0.5       |
| Camp Creek   | B-2     |           | 8.0  | 153        | 619        | 2.0  | 6.8        | 8.4        | 1.2    | 10.1 | 13.8       | 1.4   | .040         | .040      | 1.0        | .025    | .06         | 1.7   | 6.6       |
| Doe Creek  | C-4     | 7.7       | 5.4  | 25         | 116        | 0.7  | 3.9        | 6.5        | 1.7    | 6.5  | 11.0       | 1.7   | .040         | .024      | 1.7        | .026    | .08         | 0.0   | 0.0       |
| Poop Creek   | 2-B     |           | 4.0  | 10         | <u>35</u>  | 0.6  | <u>2.9</u> | 8.0        | 2.8    | 4.8  | 11.5       | 2.4   | .045         | .024      | <u>1.9</u> | .059    | <u>. 17</u> | 1.1   | 4.5       |
| Averages   |         |           |      | 78         | 279        | 1.0  | 4.9        | 9.7        | 2.0    | 7.3  | 13.9       | 2.0   | .043         | .025      | 1.9        | .035    | .10         | 2.6   | 5.5       |

|                 | <u>TA</u> | BLE 8. | SUMMAR | Y OF F | RIMARY     | HYDRAU | LIC PA | RAMETE | S FOR P    | IPES AN | D PIPE-       | ARCHES | WITH NO | SPECIA | L FEATU | <u>res</u> |           |           |           |
|-----------------|-----------|--------|--------|--------|------------|--------|--------|--------|------------|---------|---------------|--------|---------|--------|---------|------------|-----------|-----------|-----------|
|                 |           |        |        |        |            |        |        | Q2     |            |         | Q50           |        | _       |        |         |            |           | Q2        | Q50       |
| •               |           | SPAN   | RISE   | Q2     | Q50        | Q50    | Vch    | ٧b     |            | Vch     | Υb            |        |         |        |         | S          | D50       | Scour     | Scour     |
| STREAM NAME     | REF. NO   | FT     | FT     | CFS    | <u>CFS</u> | HW/R   | FPS    | FPS    | Vb/Vch     | FP\$    | FPS           | Vb/VcI | Nch     | Nb     | Nch/Nt  | FT/FT      | <u>FT</u> | <u>FT</u> | <u>FT</u> |
| 1               |           |        |        |        |            |        |        |        |            |         |               |        |         |        |         |            |           |           |           |
| Polallie Creek  | C-7       | 12.7   | 7.25   | 425    | 1090       | 1.3    | 9.2    | 21.5   | 2.3        | 11.6    | 29.5          | 2.5    | .045    | .015   | 3.0     | .043       | .25       | 13.5      | 22.9      |
| Tamarack Gulch  | 15-A      | 6.0    | 3.9    | 11     | 55         | 0.7    | 2.9    | 5.5    | 1.9        | 4.7     | 9.6           | 2.0    | .040    | .024   | 1.7     | .033       | .02       | 0.9       | 3.3       |
| South Fork      |           |        |        |        |            |        |        |        |            |         |               |        |         |        |         |            |           |           |           |
| Chesnimus Creek | 15-B      |        | 6.7    | 23     | 107        | 0.6    | 3.6    | 8.0    | 2.2        | 5.3     | 12.5          | 2.4    | .040    | .024   | 1.7     | .030       | .06       | 2.3       | 5.6       |
| Sheep Creek     | 13-E      |        | 7.0    | 20     | 150        | 0.7    | 4.5    | 9.0    | 2.0        | 9.1     | 16.0          | 1.8    | .050    | .024   | 2.1     | .053       | .25       | 1.4       | 8.4       |
| Canyon Creek    | 12-A      | 12.6   | 8.1    | 215    | 675        | 1.2    | 6.8    | 11.1   | 1.6        | 9.1     | 15.6          | 1.7    | .045    | .024   | 1.9     | .020       | .07       | 4.3       | 8.1       |
| Pine Creek      | 3-A       |        | 7.5    | 250    | 665        | 1.5    | 8.1    | 13.7   | <u>1.7</u> | 10.2    | <u> 17. T</u> | 1.7    | .045    | .024   | 1.9     | .026       | .13       | 6.8       | 10.5      |
| Averages        |           |        |        | 157    | 457        | 1.0    | 5.9    | 11.5   | 2.0        | 8.3     | 16.7          | 2.0    | .044    | .023   | 2.1     | .034       | .13       | 4.9       | 9.8       |

- 4. WFLHD personnel rated the hydraulic compatibility of arches and culverts with natural stream beds as compatible. However, they rated the hydraulic compatibility of culverts with and without special features as incompatible.
- 5. For the 50-year flood (Q50), Tables 5 through 8 show an average headwater to rise ratio of 1.0 for all culvert classes except for the pipe and pipe-arches with natural stream beds. For these culverts, the headwater to rise ratio is 0.6.
- 6. For the 2-year flood (Q2), Tables 5 and 6 show the culverts with natural stream beds and the arches have culvert barrel velocities that on average exceed the natural stream channel velocity by 10 to 20 percent. According to Tables 7 and 8, the culvert barrel velocity is twice the natural stream channel velocity for the culverts with and without special passage features.
- 7. For the 2-year flood, Tables 5 and 6 show the average computed outlet scour for culverts with natural stream beds and arches as 0.0 foot and 0.6 foot, respectively. According to Tables 7 and 8, the culverts with and without special features have average computed outlet scours of 4.9 feet and 2.6 feet, respectively.
- 8. For the 2-year flood, Tables 5 through 8 show the average stream channel velocity to be 4.4 feet per second to 5.9 feet per second for the four culvert classes. For the 50-year flood, the stream channel velocities

averaged from 6.9 feet per second to 8.3 feet per second. For comparison, Table 9 and Figure 3 present fish speeds for various species and stream conditions (10). A comparison of these values to the computed barrel velocities illustrates that the arches and the culverts with natural stream beds provide the best fish passage facilities for various fish species.

For informational purposes, Figures 4 through 8 show the graphical relationships for several of the above key parameters. Specifically, Figures 4 through 6 show the relationship between fish passage capability and headwater to culvert rise ratio, fish passage capability and culvert barrel velocity to stream channel velocity ratio, and fish passage capability and computed outlet scour, respectively. Figure 7 shows the scatter of data for culvert foundation condition versus fish passage capability. Finally, Figure 8 shows the relationship between the observed outlet scour and the computed outlet scour.

Using simple linear regression analysis, Figures 5 and 8 show the strongest statistical relationships occur between fish passage ratings and the barrel/channel velocity ratio and between the observed outlet scour ratings and the computed outlet scour. Conversely, Figure 4 shows little or no relationship between the fish passage ratings and the headwater to rise ratio, while Figure 6 shows a weak relationship between the computed outlet scour and the fish passage capability of the culvert.

TABLE 9. Fish Speeds of Average Size Adult Salmon and Steelhead Trout, Bell (1973).

|                          |                    | Fish Speed (fps)       |           |
|--------------------------|--------------------|------------------------|-----------|
| Specie                   | <u>Sustained</u> b | Prolonged <sup>b</sup> | Burst     |
| Steelhead                | 0-4.6              | 4.6-13.7               | 13.7-26.5 |
| Chinook                  | 0-3.4              | 3.4-10.8               | 10.8-22.4 |
| Coho                     | 0-3.4              | 3.4-10.6               | 10.6-21.5 |
| Sockeye                  | 0-3.2              | 3,2-10,2               | 10.2-20.6 |
| Pink & Chum <sup>a</sup> | 0-2.6              | 2.6-7.7                | 7.7-15.0  |

Pink and Chum salmon values estimated from leap heights of 3 to 4 feet at waterfalls.

b Called cruising and sustained, respectively, in Bell (1973).

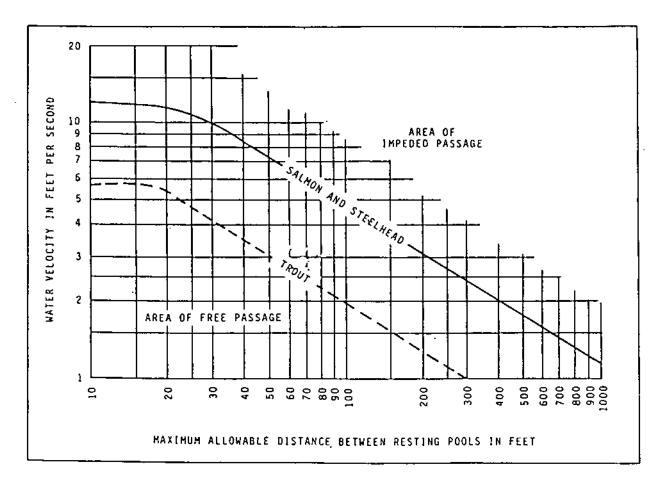
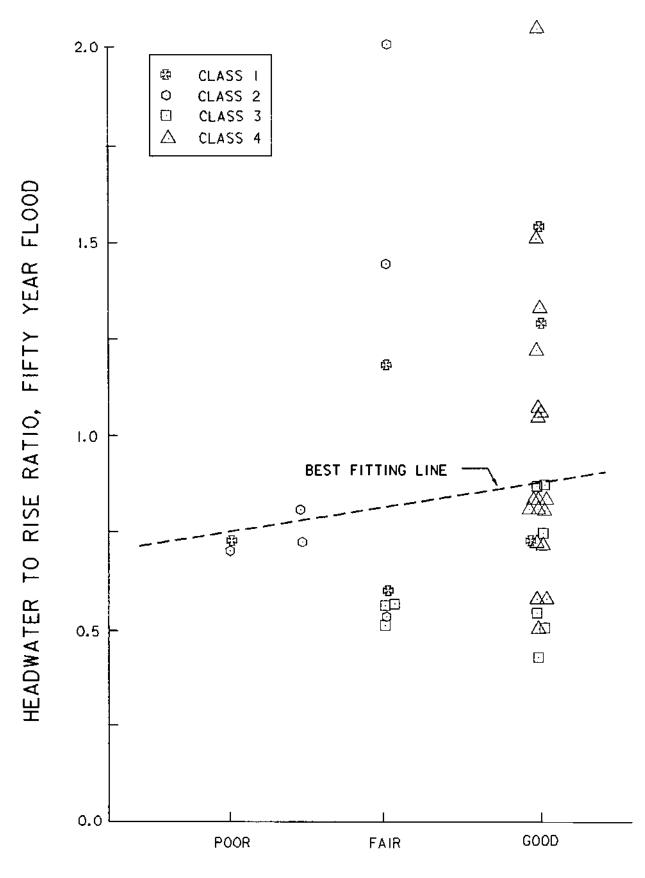
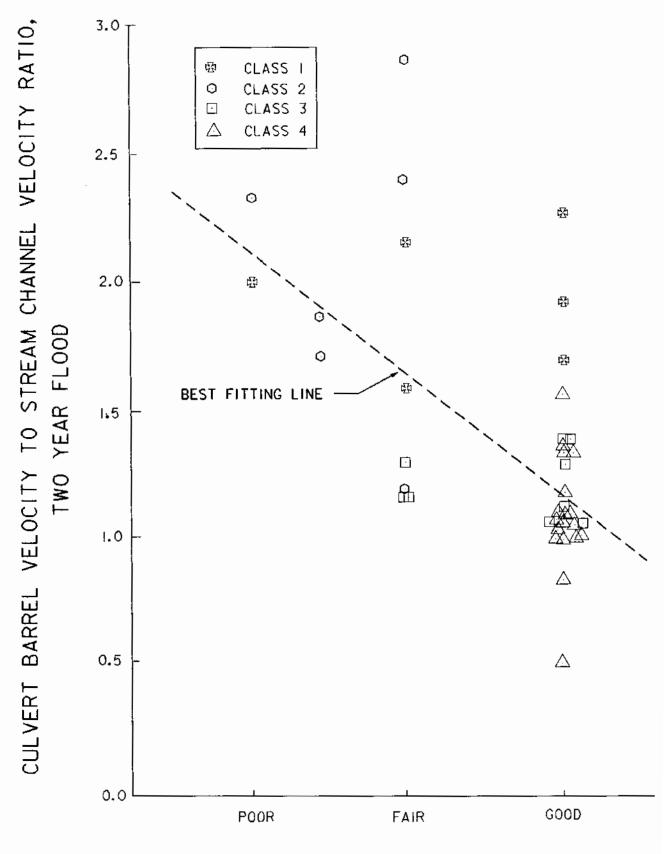


FIGURE 3. Swimming performance of salmon and trout from Evans and Johnston (1980). Curve developed by Ziemer, State of Alaska, Department of Fish and Game.



FISH PASSAGE CAPABILITY

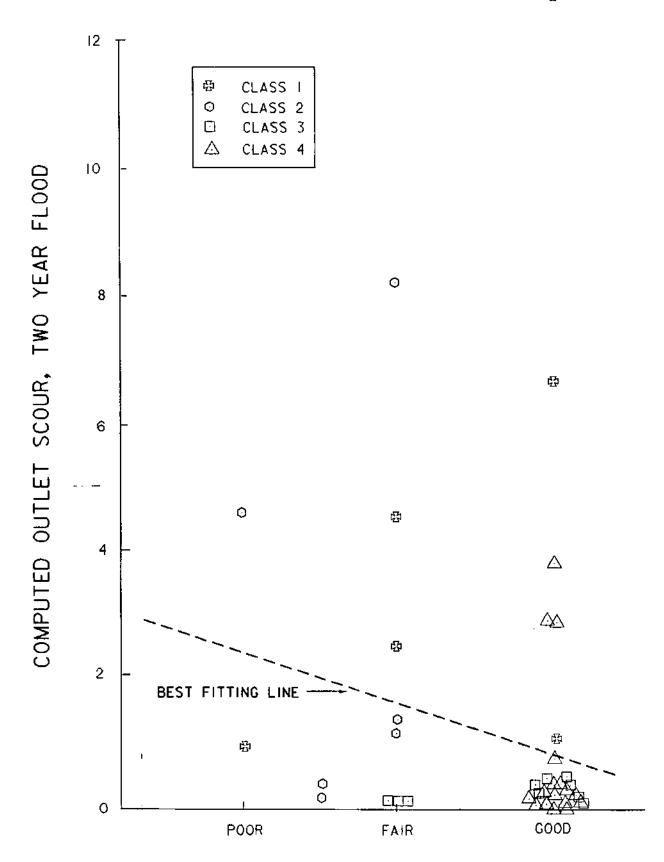
FIGURE 4



FISH PASSAGE CAPABILITY

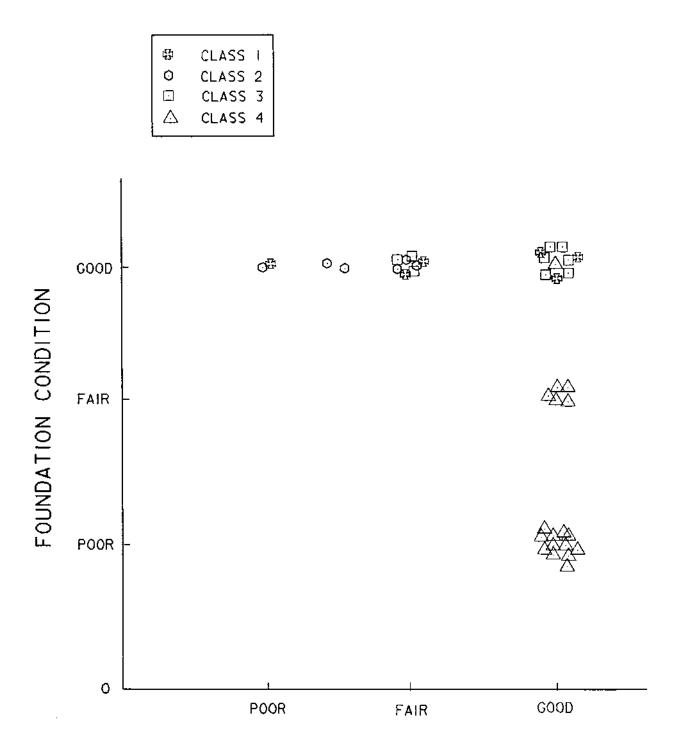
FIGURE 5





FISH PASSAGE CAPABILITY

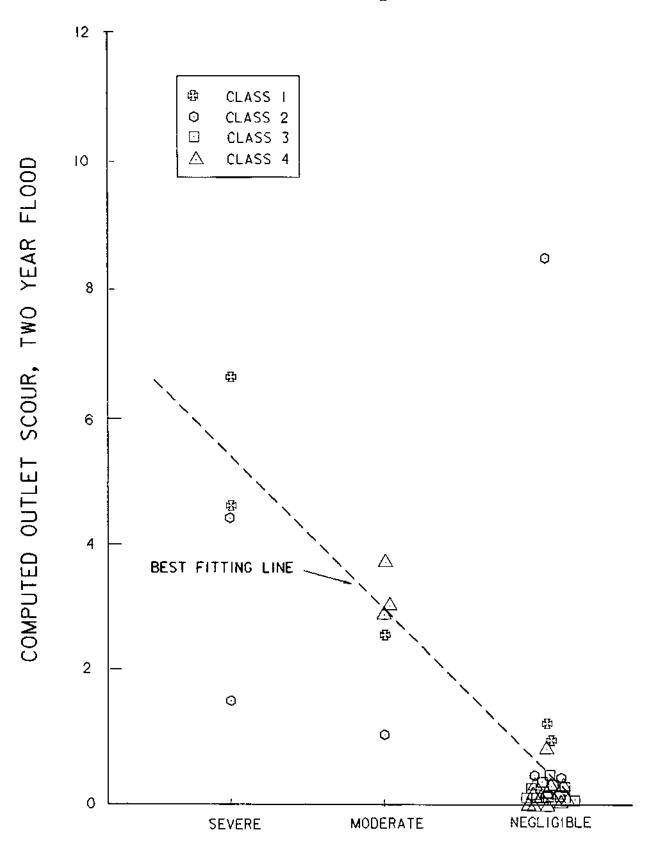
FIGURE 6



FISH PASSAGE CAPABILITY

FIGURE 7





OBSERVED OUTLET SCOUR

FIGURE 8

#### CONCLUSIONS

Based upon the information in the tables and appendices, the arches and the pipe and pipe-arches with natural stream beds are the best fish passage culverts. Also, the tables and appendices show that the WFLHD design analysis provides a good approach for rating the fish passage capabilities of the culverts. For example, the WFLHD analysis shows that the arches and culverts with natural stream beds should have barrel velocities comparable to the natural stream velocities. Furthermore, the analysis shows that outlet scour for these culverts should not be a problem. Since unnaturally high barrel velocities and outlet scour "holes" are normally the major impedances to fish passage at culvert sites, proper analysis of these items should insure a proper fish passage design (7).

Conversely, the ODFW ratings and the WFLHD survey and analysis show that the culverts with and without special features provide only fair fish passage characteristics. According to WFLHD analysis, these culverts are hydraulically incompatible with the local stream environment. of the culverts had mitigating features such as short lengths and downstream influences which allowed the fish to migrate upstream through the culvert (see Figure 1)(10). On the other hand, special features such as downstream ladder or weir systems in some instances became an impedance to fish passage during low flows. Thus, the culvert designer should analyze the special features such as baffles and downstream fish ladders for a variety of flow conditions. Also, these systems may require periodic maintenance.

#### RECOMMENDATIONS

Finally, WFLHD recommends the culvert designer use pipe and pipe-arches with natural stream beds instead of arches. With only a few exceptions, the installer could have placed a pipe or pipe-arch with a natural stream bed surface instead of the arch. However, if the installer can place the arch footings on bedrock or below the expected scour depth with proper structural support, then the arch may be a viable alternative. For their survey, WFLHD rated nearly all the arch foundations as poor or fair because of shallow footings placed on erosive material. As stated earlier, the stream velocities for the 2-year flood ranged from 4 to 6 fps, while the velocities for the 50-year flood ranged from 6 to 8 fps. Using the Fortier and Scobey maximum erosive velocities within the arch barrels. Thus, the arches with shallow footings on erosive materials (i.e., silt, sand, gravel) are highly susceptible to scour and final foundation failure during a large flood.

#### Design Procedures

Based upon the above, WFLHD recommends the following design procedures for culvert fish passage designs:

1. The designer should select a stream discharge for analyzing the fish passage characteristics and a stream discharge for analyzing the serviceability of the culvert. As a minimum, the designer should select the 2-year and 50-year floods for the respective analyses. If possible, the designer should analyze the hydraulic characteristics for other discharges such as 7-day highs and 7-day lows. Preferably, the designer should rate the hydraulic conditions of the stream and culvert for a wide variety of flow conditions (8).

2. Using the topographic data of the stream site and the selected culvert size, the designer should determine the pipe headwater-to-rise ratio for each of the selected discharges. Also, the designer should determine the culvert barrel depth and velocity and the natural stream channel depth and velocity for each of the same discharges. Concurrently, the designer should determine the culvert outlet depth and velocity and the corresponding culvert outlet scour. Finally, the designer should compare the computed stream channel and culvert depths and velocities against the maximum permissible values for stream erosion. For this analysis, WFLHD recommends the methods in the "Design Analysis" section of this report (i.e., USGS regression equations, FHWA HDS No. 5 and HEC 14).

#### Design Criteria

To aid in the above design process, WFLHD recommends the following culvert selection criteria:

The culvert headwater-to-rise ratio should not exceed 1.0. As a minimum, this criteria should be applicable to the discharge the designer selects for analyzing the serviceability of the culvert (i.e., 50-year flood). This item should insure that the culvert inlet does not excessively constrict the stream. Thus, this will reduce the chance of upstream

debris depositions and blockages and high inlet velocities that may impede fish passage.

- 2. The culvert barrel velocity should not exceed the natural stream channel velocity by more than 25 percent. As a minimum, this criteria should be applicable for discharges having a flood magnitude of 2 years or less. Ideally, the culvert barrel flow depths and velocities should match those of the natural stream channel as close as possible. However, natural streams may experience fluctuations in velocities as large as 50 percent from one stream section to the next for the same discharge. Thus, this criteria should insure reasonable passage of fish under most normal flow conditions.
- 3. The culvert outlet scour should not exceed 0.5 foot. As a minimum, this criterion should be applicable for discharges having a flood magnitude of 2 years or less. Ideally, the outlet scour should be nearly zero foot. However, the outlet scour depth will decrease as the stream flow decreases. Thus, the designer should expect the actual outlet scour during normal flow conditions to be less than the computed value for the 2-year flood.

#### Installation Criteria

WFLHD recommends the following installation procedures for pipe and pipe-arches with natural stream bed surfaces:

- 1. For culverts 10 feet or less in equivalent diameter, the installer of the culvert should set the barrel invert a minimum of 12 inches to 24 inches below the natural stream bed slope. For culverts with equivalent diameters larger than 10 feet, the installer should place the culvert barrel a minimum of one fifth the culvert rise below the natural stream bed slope.
- 2. The installer should fill the culvert barrel with materials that are similar to the natural stream bed materials. This will insure a culvert barrel roughness comparable to the stream channel roughness. Tables 5 and 6 show the culvert velocity will be comparable to the natural stream velocity if the culvert barrel roughness, Nb, is comparable to the stream channel roughness, Nch.

In some instances, the existing stream bed may consist of cohesive materials such as clays and silt. These materials may not be suitable for relocation into the culvert barrel due to a reduction in their cohesiveness during the installation. Instead, the installer should consider fine or coarse gravel for the culvert stream bed surface. Eventually, the culvert stream bed should reach a material composition comparable to the natural stream bed. This will occur as the stream

deposits clay and sand-size particles within the barrel during low flows and the stream transports the gravel size particles away during high flows.

Initially, during low flow periods, the stream flow could submerge into the stream bed gravel. This is likely to happen when the installer performs extensive excavation upstream and downstream of the culvert and directly underneath the culvert for foundation purposes. Although the stream bed should eventually "seal" itself with the deposition of finer materials, the installer should consider placing a nonpermeable barrier between the stream bed materials and the foundation materials. This action should reduce the potential of the stream flow to submerge.

- 3. The installer should place the culvert barrel materials described under Item 2. to match the original or local stream bed elevations. This should insure a bed slope through the barrel comparable to the local stream bed slope.
- 4. The installer should place the culvert barrel itself on as flat a slope as possible. In general, the installer should limit culvert barrel to a slope steepness of 2 percent. This criteria should encourage barrel deposition of new materials during low flows to replace existing materials transported away during high flows. If the installer must place the culvert barrel on a slope steeper than 2 percent, then the installer should consider placing baffles inside the barrel to retain the stream bed materials (9).

The installer should also consider the sediment transporting capability of the stream before deciding on the final slope of the culvert barrel. Furthermore, the installer should consider the depth of materials placed within the culvert and the culvert's impact upon the hydraulics (i.e., velocity) before a final decision. If the culvert bed material depth is more than the expected local scour depth, then the culvert barrel slope may be irrelevant to maintaining a natural stream bed material within the culvert. However, if the installer cannot meet these conditions, then the installer should consider flattening the culvert barrel slope.

- 5. If the installer cannot develop a culvert layout that matches the hydraulic design criteria, then the installer should consider placing small boulders within the culvert. The boulders should reduce the overall barrel velocities as well as create a velocity profile comparable to that of a natural stream. In general, a culvert velocity profile that varies similar to the natural stream profile may be more important than the overall barrel velocity. For example, most fish can travel against high water velocities for short distances as shown in Figure 2 and Table 9 (10). Thus, a series of small boulders within the culvert should reduce the chances that the fish will have to travel upstream through the culvert at sustained high speeds. If the installer places small boulders within the barrel, the installer should embed them into the culvert bed materials. To reduce the potential for debris collection, the boulders should not protrude more than 12 inches above the culvert bed surface.
- 6. If outlet scour is a possible problem, then the installer should place boulders just downstream from the culvert outlet. This should dissipate

the stream's energy and reduce the potential scour depth. However, if stream degradation downstream from the culvert is also a potential problem, then the whole culvert installation may require lowering to anticipate an overall lower stream bed surface. In other cases, the installer may eventually have to replace the culvert with a new culvert.

While the subject of fish passage will require more research, WFLHD believes that sufficient design methods exist to ensure that culverts can pass fish under normal flow conditions. Hopefully, this study supports this conclusion.

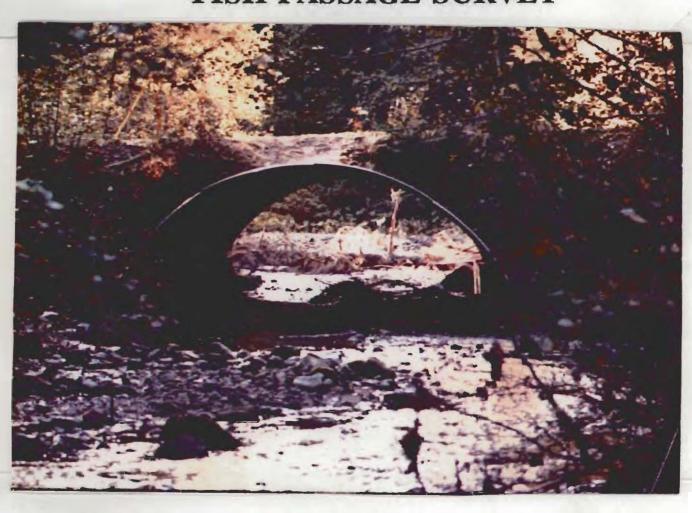
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- "Analysis of Barriers to Upstream Fish Migration," Washington State University, January 1986.
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- 12 "Hydrology," HEC 19, Federal Highway Administration, August 1985.
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- "Design Charts for Open-Channel Flow," HDS No. 3, Federal Highway Administration, May 1973.
- "Appendix to a Hydraulic Evaluation of Fish Passage through Roadway Culvert in Alaska Data Report," RD-85-24A, Alaska Department of Transportation and Public Facilities, May 1985.

## NO. REFERENCE

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- "Spawning Migration of Arctic Grayling through Poplar Grove Creek Culvert," RD-88-09, Alaska Department of Transportation and Public Facilities, March 1988.

# APPENDICES TO OREGON CULVERT FISH PASSAGE SURVEY



October 1990

Western Federal Lands Highway Division, Federal Highway Administration

# APPENDIX A

WFLHD FIELD DATA CHECKLIST

#### CHECKLIST FOR THE FIELD INVESTIGATION OF SELECTED OREGON CULVERTS

#### I. Stream Cross Sections

#### A. Location\*

- 1. At the culvert outlet.
- At the culvert inlet.
- 3. At the location which is most representative of the natural stream section below the culvert outlet (i.e., 50 to 200 feet d/s from the culvert outlet).
- 4. At the location which is most representative of the natural stream section above the culvert inlet (i.e., 50 to 200 feet v/s from the culvert inlet).
- 5. At the location of maximum culvert outlet scour.
- B. Special Details Elevations and Distances of the Following Features Should Be Obtained:
  - The edge of water.
  - The top and bottom of footings and walls that support the culvert.
  - 3. The top and bottom of the culvert outlet and inlet.
  - High-water marks.

\*Note: Measure distances between all cross sections.

#### II. Culvert Details

- A. Size (i.e., pipe diameter or maximum span and maximum rise)
- B. Type (i.e., structural plate pipe-arch, structural plate arch, corrugated metal pipe, structural plate pipe)
- C. Material (metal or concrete)
- D. Special Features
  - 1. Baffles.
    - Typical spacing and size, typical layout, and type (wood or metal).
  - Footings, support walls, metal cross ties.
    - Typical size, typical layout, type (concrete or metal).
  - Outlet features (man-made).
    - a. Type (i.e., log barriers, pools, and weirs, gabion baskets), typical layout, typical size.

#### III. Special Stream Features

- A. Culvert Outlet Scour
  - 1. Maximum length and width of scour hole.
- B. Deposition of Stream Bed Material Within the Culvert Barrel
  - Average depth, length, and width of deposited material.

#### C. Natural Barriers

- 1. Type (i.e., logs or rocks), typical size, typical layout (i.e., distance from culvert inlet or outlet).
- D. Surface Velocity Through Culvert Barrel
- E. Adjacent Streams and Man-Made Structures Which May Influence the Hydraulic Characteristics of the Culverted Stream
  - Distance and direction of adjacent streams and man-made structures from the culvert (i.e., inlet or outlet).
  - 2. Approximate dimensions of adjacent streams and man-made structures (i.e., average width and average depth of stream, length of bridge, pipe diameter).

#### IV. Stream Material Sampling

#### A. Location\*\*

- 1. Upstream of culvert inlet.
- Downstream of culvert outlet.
- Inside Culvert Barrel.
- 4. Scour hole areas.

#### B. Quantity and Depth

- Standard material sample bags should be filled with enough material for performing sieve gradation analysis.
- Samples should extend to a depth of 12 inches into the existing stream bed.

<sup>\*\*</sup>Stream bed samples need not be taken at each of these locations if the material does not appear to differ in composition from location to location.

## V. Photographs

- A. Facing Downstream from the Culvert Outlet
- B. Facing Upstream from the Culvert Inlet
- C. The Culvert Outlet
- D. The Culvert Inlet
- E. Special Features (i.e., scour holes, man-made structures, adjacent streams, log barriers within sight distance of the culvert location)

## VI. Documentation

- A. "Hydraulic Site Evaluation" Form
- B. Standard Survey Field Books for Stream Cross-Section Data

# APPENDIX B EVALUATION FORMS

| EF. NO. 1-A |  |
|-------------|--|
| EF. NO. 1-A |  |

# FISH PASSAGE EVALUATION FORM

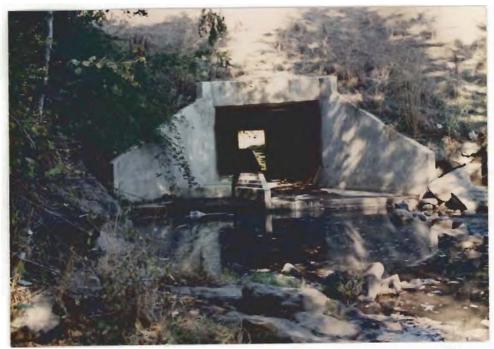
| DATE: 10/15/87 DATA BY: Bill Howard, James Bryant                                    |
|--|
| STREAM: Mt. Scott Creek ODF&W REP.: Jay Massey                                       |
| LOCATION: Approximately 1 + mile off I-205 east on Sunnyside Road,                   |
| Clackamas County; T2S, R2E, Section 3  |
| TYPE OF INSTALLATION: Concrete Box Culvert   |
| DIMENSIONS: SPAN 10.0' RISE 8.0' DIAM.   |
| LENGTH182'   |
| GRADIENT01750 foot/foot  |
| SPECIAL FEATURES: Fish baffles on approximately 4 foot spacings.                     |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                                 |
| 1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and                      |
| winter steelhead. Resident trout population also present.                            |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                                    |
| CRITICAL X* MODERATE NONCRITICAL   |
| *Critical for salmon and steelhead; important for resident trout.                    |
|  |
| 3. EVALUATION OF INSTALLATION:   |
| GOOD FAIR POOR X   |
| 4. COMMENTS:<br>Baffle construction not adequate at downstream end of culvert. Water |
|  |
| spreads out over apron below lower baffle (fish do not have concentrated             |
| flow to jump into). Probably not passable at moderate to low flow.                   |
| CORRECTION NEEDED - Add training walls to concentrate flow from lower                |
| baffle to edge of the apron. The remainder of the installation looks                 |
| fine.  |
|  |

SHEET 2 OF 3

| REF. | NO. | ] -A |  |
|------|-----|------|--|
|      |     |      |  |

# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                 |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR POOR  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE X MODERATE NEGLIGIBLE   |
| 6. | CULVERT STREAM SURFACE   |
|    | METAL CONCRETEX NATURAL  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS                        |
|    | COMPATIBLE INCOMPATIBLEX   |
| 8. | COMMENTS: To mitigate the outlet problems, a log barrier system should |
| •  | be installed downstream from the culvert outlet to create a pool       |
|    | extending into the culvert barrel. The pool would reduce outlet        |
|    | velocities and outlet scour depths. The pool would also provide        |
|    | sufficient flow depths for fish desiring passage through the culvert   |
|    | during low flow periods.   |



1Aa - Culvert Outlet



1Ab - Typical Stream Channel

| REF |   | NO. | 1 <b>-</b> B |  |
|-----|---|-----|--------------|--|
|     | • |     | . •          |  |

# FISH PASSAGE EVALUATION FORM

| DATE: 10/15/87                | DATA BY: Bill Howard, James Bryant                |
|-------------------------------|---|
| STREAM: Newell Creek          | ODF&W REP.: Jay Massey                            |
| LOCATION: 1.75 miles south of | I-205 junction on Hwy. 213, Cascade Hwy.,         |
| Clackamas County; T           | 2S, R2E, Sections 32 and 33                       |
| TYPE OF INSTALLATION: Steel   | Structural Plate Pipe                             |
| DIMENSIONS: SPAN              | RISE DIAM14'                                      |
| LENGTH 438'                   |   |
| GRADIENT 0.01                 | foot/foot_  |
| SPECIAL FEATURES: Natural st  | ream bed materials and boulders placed throughout |
| the culvert length.           |   |
| EVALUATION OF PASSAGE FACILIT | IES BY ODF&W PERSONNEL:                           |
| 1. TYPE AND CONDITION         | OF SPECIES: Small runs of Coho salmon and winter  |
| steelhead. Also st            | ream has resident trout population.               |
| 2. IMPORTANCE OF INSTA        | LLATION TO SUBJECT SPECIES:                       |
| CRITICAL X* MO                | DERATE NONCRITICAL                                |
| *Critical for coho            | and steelhead and important for trout.            |
| 3. EVALUATION OF INSTA        | ALLATION:   |
| GOOD X FAIR _                 | POOR  |
| 4. COMMENTS:                  |   |
| Excellent installation f      | or fish passage.                                  |
|                               |   |
|                               |   |
|                               |   |
| <del></del>                   |   |

SHEET 2 OF 3

| REF. NO. 1-B |  |
|--------------|--|
|--------------|--|

| EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSON | EVALUATION | LLATION BY WFLHD PERSON | Т | CULVE | 0F | EVALUATION |
|--|------------|-------------------------|---|-------|----|------------|
|--|------------|-------------------------|---|-------|----|------------|

| ١. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                  |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS                         |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: While the above culvert could possibly be reduced in diameter |
| •  | size without significantly affecting its ability to service the highway |
|    | and fish passage, overall, the culvert is a good installation for the   |
|    | given design criteria and field conditions.                             |
|    | given accign of the two discretes constitutions                         |



1Ba - Culvert Outlet



1Bb - Typical Stream Channel

| REF. | NO. | 1-C |  |
|------|-----|-----|--|
|      |     |     |  |

# FISH PASSAGE EVALUATION FORM

| DATE: 10/19/87 DATA BY: Bill Howard, James Bryant                       |
|---|
| STREAM: Cool Creek ODF&W REP.: Jay Massey                               |
| LOCATION: 2-1/2 miles of US 26 on Still Creek Road, Clackamas County;   |
| T3S, R7E, Section 24  |
| TYPE OF INSTALLATION: Aluminum Structural Plate Arch                    |
| DIMENSIONS: SPAN 14.7' RISE 9.5' DIAM.                                  |
| LENGTH 48'  |
| GRADIENT 0.01 foot/foot   |
| SPECIAL FEATURES: Open bottom arch. Top of footings appear to be 4 feet |
| below stream bed. Man-made pools were built at outlet with log and rock |
| barriers.   |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                    |
| 1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winte   |
| steelhead. Resident trout also in stream.                               |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
| CRITICAL X* MODERATE NONCRITICAL  |
| *Critical for salmon and steelhead; important for resident trout.       |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD X FAIR POOR  |
| 4. COMMENTS: Very good open bottom arch. Man-made pools at outlet ma    |
| require periodic maintenance.   |
|   |
|   |
|   |
|   |

SHEET 2 OF

| EVALUATION OF CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|-----------------------|--------------|----|-------|------------|
|-----------------------|--------------|----|-------|------------|

| ١. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR POOR _X  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR X POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING _X CLOSED                           |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR X POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                   |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: Despite the poor installation procedures, the Cool Creek |
|    | culvert is a good fish passage design.                             |
|    |  |
|    |  |
|    |  |



1Ca - Culvert Inlet



1Cb - Typical Stream Channel

| REF. | NO. | 1-D |  |
|------|-----|-----|--|
|      |     |     |  |

# FISH PASSAGE EVALUATION FORM

| DATE: 10/20/87 DATA BY: Bill Howard, James Bryant                   |          |
|---|----------|
| STREAM: Lost Creek ODF&W REP.: Jay Massey                           |          |
| LOCATION: Spur Road 109, Clackamas County; T2S, R8E, Section 21     |          |
|   |          |
| TYPE OF INSTALLATION: Steel Structural Plate Arch                   |          |
| DIMENSIONS: SPAN 18.2' RISE 5.6' DIAM.                              |          |
| LENGTH 50'  |          |
| GRADIENT014 foot/foot   |          |
| SPECIAL FEATURES: Open bottom arch. Bottoms of concrete footings as | e esti-  |
| mated to be only 2 feet below the existing stream bed.              |          |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                |          |
| 1. TYPE AND CONDITION OF SPECIES: Fair runs of Coho salmon and      | l winter |
| steelhead. Resident trout also in stream.                           |          |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                   |          |
| CRITICALX* MODERATE NONCRITICAL                                     |          |
| *Critical for salmon and steelhead; important for resident          | rout.    |
| 3. EVALUATION OF INSTALLATION:                                      |          |
| GOOD X FAIR POOR  |          |
| 4. COMMENTS: Excellent open bottom arch arch.                       |          |
|   |          |
|   |          |
|   |          |
|   |          |
|   |          |

| SHEET | 2 0 | F 3 |  |
|-------|-----|-----|--|
| REF.  | NO. | 1-D |  |

| FVALUATION   | ΩF | CHI VERT | INSTALLATION | RY | WEI HD | PERSONNE1 + |
|--------------|----|----------|--------------|----|--------|-------------|
| E AMERIALION | Uľ | CULYERI  | INDIALFAITON | DΙ | KL LUD | LTKJOMMTT.  |

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR X POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTINGX CLOSED                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POOR _X   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURALX   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: While the above culvert provides good fish passage, a pipe      |
|    | culvert with its metal invert depressed below the natural stream bed      |
|    | would eliminate the possibility of a foundation failure during an extreme |
|    | flood. Also, log and/or rock barriers could be installed downstream to    |

ensure that the "depressed" culvert did not lose its streambed material.



1Da - Culvert Outlet



1Db - Typical Stream Channel

| REF. NO. | C-7 |
|----------|-----|
|----------|-----|

# FISH PASSAGE EVALUATION FORM

| DATE: 10/20/87                | DATA BY: Bill       | loward, James Brya | nt             |
|-------------------------------|---------------------|--------------------|----------------|
| STREAM: Polallie Creek        | ODF&W REP           | :Jim_Newton        |                |
| LOCATION: 23.2 miles south o  | Hood River and I-8  | 34 junction on US  | 35, Hood       |
| River County; T2S,            | R10E, Section 5     |                    |                |
| TYPE OF INSTALLATION: _Stee1  | tructural Pipe-Arcl | 1                  | <del></del>    |
| DIMENSIONS: SPAN 12.7'        | RISE                | DIAM.              |                |
| LENGTH110'                    |                     |                    |                |
| GRADIENTO.O                   |                     |                    |                |
| SPECIAL FEATURES: Pipe inv    | rt is lined with c  | oncrete. Another   | pipe is        |
| located at the site for flood | relief. The addit   | ional pipe is a 7  | foot           |
| diameter corrugated steel pip | with no special f   | eatures for fish   | passage.       |
| EVALUATION OF PASSAGE FACILIT | ES BY ODF&W PERSON  | NEL:               |                |
| 1. TYPE AND CONDITION         | F SPECIES: May pr   | ovide some rearing | g for resident |
| trout and possibly            | small number of s   | teelhead.          |                |
| 2. IMPORTANCE OF INSTA        | LATION TO SUBJECT   | SPECIES:           |                |
| CRITICAL MO                   | ERATE NONC          | RITICAL X          |                |
| 3. EVALUATION OF INSTA        | LATION:             |                    |                |
| GOOD X FAIR                   | POOR                |                    |                |
| 4. COMMENTS: Polallie         | Creek is an unstab  | le, high gradient  | , high         |
| velocity stream with li       | tle fish production | on potential. Th   | is stream was  |
| devastated by the sudde       | draining of a gla   | cial impoundment   | on the slopes  |
| of Mt. Hood in 1980.          | The entire stream   | was severely so    | coured by the  |
| ensuing flood, which al       | o destroyed portio  | ns of Highway 35   | and miles of   |
| the East Fork of Hood Ri      | /er                 |                    |                |
| Polallie Creek has ne         | er been considere   | ed a significant   | resident or    |
| anadromous fish producer      |                     |                    |                |
|                               |                     |                    |                |

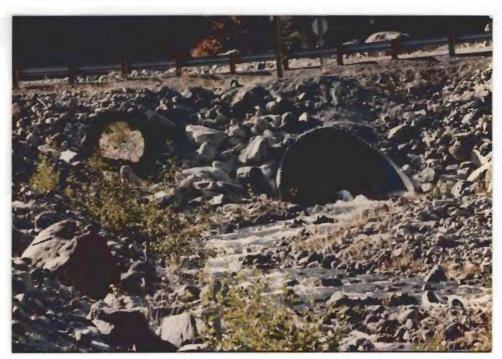
SHEET 2 OF 3

REF. NO. C-7\_\_\_\_\_\_

| EVAL | UATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:                     |
|------|--|
| 1.   | CULVERT CONDITION:   |
|      | GOOD X FAIR POOR POOR  |
| 2.   | CULVERT CAPACITY:  |
|      | GOOD FAIR X POOR   |
| 3.   | TYPE OF CULVERT FOUNDATION:  |
|      | METAL FOOTING CONCRETE FOOTING CLOSED X                                |
| 4.   | CONDITION OF FOUNDATION:   |
|      | GOOD X FAIR POOR   |
| 5.   | OUTLET SCOUR:  |
|      | SEVERE MODERATE NEGLIGIBLE   |
| 6.   | CULVERT STREAM SURFACE:  |
|      | METAL CONCRETE _ X NATURAL   |
| 7.   | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                       |
|      | COMPATIBLE INCOMPATIBLEX_  |
| 8.   | COMMENTS: In general, the above facility is not considered a good      |
|      | installation for fish passage. If the culvert were to be replaced with |
|      | fish passage as a design criteria, the culvert installation would      |
|      | probably require oversizing or the placement of baffles and/or natural |

stream bed materials such as gravels and small boulders to sufficiently

reduce stream velocities through the culvert facility.



C7a - Culvert Outlet



C7b - Typical Stream Channel

| DEE  | NO  | 14-A |
|------|-----|------|
| REF. | NU. | 14-A |

# FISH PASSAGE EVALUATION FORM

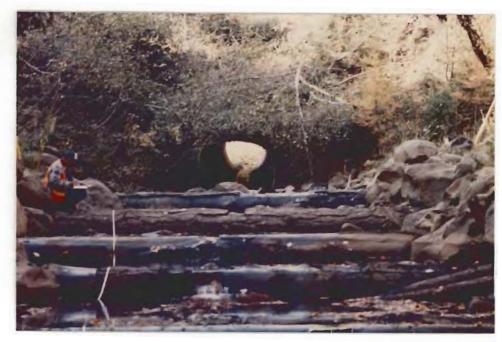
| DATE: 10/  | DATA BY: Bill Howard, James Bryant                                   |
|------------|--|
| STREAM: M  | ottet Creek ODF&W REP.: Duane West                                   |
|            | MP 7.6 on FS Road 63, Union County; T4N, R39E, Section 33            |
|            |  |
| TYPE OF IN | STALLATION: Corrugated Steel Oval Pipe                               |
| DIMENSIONS | : SPAN 5.8' RISE 7.0' DIAM.  |
|            | LENGTH 110'  |
|            | GRADIENT 0.0573 foot/foot  |
| SPECIAL FE | ATURES: Log weirs and pools are constructed at the outlet of the     |
| culvert.   |  |
| EVALUATION | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                            |
| 1.         | TYPE AND CONDITION OF SPECIES: There are good numbers of both        |
|            | rainbow trout and summer steelhead in this small tributary stream.   |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|            | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.         | EVALUATION OF INSTALLATION:  |
|            | GOOD FAIR X POOR   |
| 4.         | COMMENTS: This type of facility does an adequate job of passing fish |
|            | however, it is not as good as the open bottom arch.                  |
|            |  |
|            |  |
|            |  |
|            |  |

SHEET 2 OF 3

| KEP. NU. 14-M | REF. | NO. | 14-A |  |
|---------------|------|-----|------|--|
|---------------|------|-----|------|--|

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|            |    |         |              |    |       |            |

| ۱. | CULVERT CONDITION:   |
|----|--|
|    | GOODX FAIR POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR X POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSED _X                                 |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL X CONCRETE NATURAL   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE INCOMPATIBLEX   |
| 8. | COMMENTS: If the culvert were to be replaced in the future, the culvert  |
| •  | should be oversized and installed with baffles and/or natural stream bed |
|    | materials such as gravels and small boulders. This type of facility      |
|    |  |
|    | would significantly reduce culvert velocities and provide flow           |
|    | characteristics similar to the natural stream channel. Thus, a culvert   |
|    | facility that can provide fish passage is possible at this site.         |



14Aa - Culvert Outlet



14Ab - Typical Stream Channel

| REF. NO. 14-B |  |
|---------------|--|
|---------------|--|

| DATE: 10  | /22/87 DATA BY: Bill Howard, James Bryant                           |
|-----------|---|
| STREAM: L | ittle Looking Glass Creek ODF&W REP.: Duane West                    |
| LOCATION: | MP 4.5 on FS Road 63, Union County; T3N, R39E, Section 2,           |
|           |   |
| TYPE OF I | NSTALLATION: Steel Structured Plate Arch                            |
| DIMENSION | S: SPAN 17.6' RISE 8.0' DIAM.                                       |
|           | LENGTH 110'   |
|           | GRADIENT 0.0164 foot/foot   |
| SPECIAL F | EATURES: Open bottom arch. Gabion weirs at outlet.                  |
| EVALUATIO | ON OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1.        | TYPE AND CONDITION OF SPECIES: Both rainbow trout and summer steel- |
|           | head inhabit the stream. There are good numbers of both species.    |
| 2.        | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                      |
|           | CRITICAL X MODERATE NONCRITICAL                                     |
| 3.        | EVALUATION OF INSTALLATION:   |
|           | GOOD X FAIR POOR  |
| 4.        | COMMENTS: Little Looking Glass Creek is an important steelhead      |
|           | spawning and rearing stream. The stream above the culvert contains  |
|           | the best habitat.   |
|           |   |
|           | · · · · · · · · · · · · · · · · · · ·                               |
|           |   |

| REF.   | NO. | 14-B |  |
|--------|-----|------|--|
| N ⊑1 • | NO  | 14-0 |  |

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|            |    |         |              |    |       |            |

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR _X _ POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                   |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POOR _X   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE X  |
| 8. | COMMENTS: While the above culvert provides good fish passage, a pipe      |
|    | arch culvert with its metal invert depressed below the natural stream bed |
|    | would eliminate the possibility of foundation failure during an extreme   |
|    | flood event. Also, log and/or rock barriers could be installed            |
|    | downstream to ensure that the local fishery could traverse the gabions    |
|    | though a series of pools and weirs.                                       |



14Ba - Culvert Outlet



14Bb - Typical Stream Channel

| REF. | NO. | 15-A |  |
|------|-----|------|--|
| \    |     | 10 / |  |

| DATE: 10/24/87 DATA BY: Bill Howard, James Bryant                              |    |
|--|----|
| STREAM: Tamarack Gulch ODF&W REP.: Ken Witty                                   |    |
| LOCATION: Near Enterprise, Wallowa County; T3N, R47E, Section 34               |    |
| TYPE OF INSTALLATION: Corrugated Metal Pipe-Arch                               |    |
| DIMENSIONS: SPAN 6.0' RISE 3.9' DIAM.  LENGTH 30.7'  GRADIENT 0.0326 foot/foot |    |
| SPECIAL FEATURES: None   |    |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                           |    |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead - migratory a               | nd |
| resident rainbow trout   |    |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                              |    |
| CRITICAL MODERATE NONCRITICALX   |    |
| 3. EVALUATION OF INSTALLATION:   |    |
| GOOD X FAIR POOR   |    |
| 4. COMMENTS:   |    |
|  |    |
|  |    |
|  |    |
|  |    |

| SHEET | 72 ( | OF 3 |  |
|-------|------|------|--|
| REF.  | No.  | 15-A |  |

| EVAL | UATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:   |
|------|--|
| 1.   | CULVERT CONDITION:   |
|      | GOOD X FAIR POOR   |
| 2.   | CULVERT CAPACITY:  |
|      | GOOD X FAIR POOR POOR  |
| 3.   | TYPE OF CULVERT FOUNDATION:  |
|      | METAL FOOTING CONCRETE FOOTING CLOSEDX   |
| 4.   | CONDITION OF FOUNDATION:   |
|      | GOOD X FAIR POOR POOR  |
| 5.   | OUTLET SCOUR:  |
|      | SEVERE MODERATE NEGLIGIBLEX  |
| 6.   | CULVERT STREAM SURFACE:  |
|      | METAL X CONCRETE NATURAL   |
| 7.   | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:   |
|      | COMPATIBLE X   |
| 8.   | COMMENTS: Although this small, intermittent stream is not critical to  |
|      | the local fishery, a culvert with a rise and span comparable to the  |
|      | existing facility could easily be installed with a depressed invert. The   |
|      | depressed metal invert could be covered with small boulders and natural  |
|      | stream bed materials. This type of facility would significantly reduce   |
|      | culvert velocities and provide flow characteristics similar to the   |
|      | natural stream channel. Thus, a culvert facility that can provide fish   |
|      | The state of the s |

passage is possible at this time.



15Aa - Culvert Outlet



15Ab - Typical Stream Channel

| DEE  | NO  | 1.E. D |  |
|------|-----|--------|--|
| REF. | NU. | 15-B   |  |

| DATE: 10/24/89 DATA BY: Bill Howard, James Bryant                           |
|---|
| STREAM: South Fork Chesnimus Creek ODF&W REP.: Ken Witty                    |
| LOCATION: South of junction of FS Roads 4690, 014, and 015 on FS Road 4690, |
| Wallowa County; T3N, R47E, Section 24                                       |
| TYPE OF INSTALLATION: Corrugated Metal Pipe                                 |
| DIMENSIONS: SPAN RISE DIAM6.7'  |
| LENGTH  |
| GRADIENT 0.03 foot/foot   |
| SPECIAL FEATURES: None  |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory        |
| and resident rainbow trout.   |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                           |
| CRITICAL MODERATE _X NONCRITICAL  |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD FAIR _X POOR   |
| 4. COMMENTS: Creek was dry when inspected on 11/8/88. The downstream        |
| end of this culvert could be a barrier at lower stream flows.               |
|   |
|   |
|   |

SHEET 2 OF 3

REF. NO. 15-B

|  | EVALUATION ( | OF | CULVERT | INSTALLATION | BY | WFLHD | PERSONNEL: |
|--|--------------|----|---------|--------------|----|-------|------------|
|--|--------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOODX FAIR POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE _X NEGLIGIBLE   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL X CONCRETE NATURAL  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE INCOMPATIBLEX  |
| 8. | COMMENTS: If this culvert is to be replaced, it can be replaced with a    |
|    | culvert barrel area similar to the existing facility provided its invert  |
|    | is depressed below the natural stream bed gradient. The culvert invert    |
|    | should be backfilled with existing stream bed material and small boulders |
|    | to reduce the barrel velocities. The existing scour hole at the outlet    |
|    | should also be backfilled with similar natural materials to match the     |
|    | stream bed gradient. These measures should provide a facility that        |
|    | blends well with the surrounding stream environment and fishery habitat.  |



15Ba - Culvert Outlet



15Bb - Typical Stream Channel

| DEE  | MO  | D-6 |  |
|------|-----|-----|--|
| KEF. | NO. | D-0 |  |

SHEET 2 OF 3
REF. NO. D-6

| EVAL | UATION OF CULVERT | INSTALLATION    | BY WFLHD PERSONNEL: |
|------|-------------------|-----------------|---------------------|
| 1.   | CULVERT CONDITIO  | N:              |                     |
|      | GOOD FAI          | R <u>X</u> POOR | ·                   |
| 2.   | CULVERT CAPACITY  | :               |                     |
|      | GOOD X FAI        | R POOR          | <b>!</b>            |

5. OUTLET SCOUR:

SEVERE \_\_\_\_\_ MODERATE \_\_\_\_ NEGLIGIBLE \_X

GOOD \_\_\_\_\_ FAIR \_\_\_\_ POOR \_X

6. CULVERT STREAM SURFACE:

METAL \_\_\_\_ CONCRETE \_\_\_\_ NATURAL \_\_X\_\_

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

COMPATIBLE X INCOMPATIBLE \_\_\_\_\_

8. COMMENTS: While the above culvert provides good fish passage, a pipe-arch culvert with its invert depressed below the natural stream bed would eliminate the possibility of a foundation failure during an extreme flood event.



D6a - Culvert Outlet



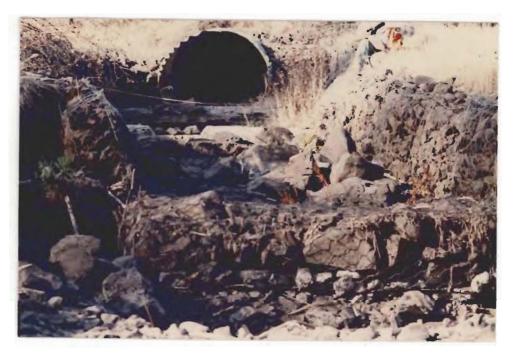
D6b - Typical Stream Channel

| RFF.  | NO.  | C-3 |  |
|-------|------|-----|--|
| W (C) | 110. | 0-0 |  |

| DATE: 10/25/87 DATA BY: Bill Howard                                       |
|---|
| STREAM: Billy Creek ODF&W REP.: Ken Witty                                 |
| LOCATION: Wallowa National Forest, Wallowa County; T3N, R47E, Section 7   |
|   |
| TYPE OF INSTALLATION: Steel Structural Plate Pipe-Arch                    |
| DIMENSIONS: SPAN 6.3' RISE 5.0' DIAM.                                     |
| LENGTH  |
| GRADIENT 0.0228 foot/foot   |
| SPECIAL FEATURES: Log weirs and gabions placed at outlet. An additional   |
| 48 inch diameter pipe has been installed for flood relief. The additional |
| 48 inch pipe has no special features for fish passage.                    |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                      |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory      |
| and resident rainbow trout  |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                         |
| CRITICAL MODERATE _X NONCRITICAL  |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD FAIR X POOR X  |
| Fair at high flows, poor at low flows.                                    |
| 4. COMMENTS: Billy Creek was dry in the vicinity of this culvert when     |
|   |
| inspected on 11/8/88. This installation and the concerns with it are      |
| similar to the situation on Doe Creek (Ref. #C-4). The weirs and gabions  |
| below the culvert create barriers during low flows.                       |

|  | <b>EVALUATION</b> | 0F | CULVERT | INSTALLATION | BY | WFLHD | PERSONNEL |
|--|-------------------|----|---------|--------------|----|-------|-----------|
|--|-------------------|----|---------|--------------|----|-------|-----------|

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX  |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX_  |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL X CONCRETE NATURAL  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:  |
|    | COMPATIBLE INCOMPATIBLE _X  |
| 0  | COMMENTS - A sull and the sull |
| ٥. | COMMENTS: A culvert with a rise and span comparable to the existing   |
|    | facility could be easily installed with a depressed invert. The   |
|    | depressed invert could be covered with small boulders and natural stream  |
|    | bed materials. This type of facility would significantly reduce culvert   |
|    | velocities and provide flow characteristics similar to the natural stream   |
|    | channel. If weirs are maintained at the site, then they should be   |
|    | designed to allow passage of fish during low flow periods by providing  |
|    | flow depths and widths comparable to the natural channel. Also, the   |
|    | water should be prevented from flowing under or through the weirs (i.e.,  |
|    | permeable rock gabions).  |



C3a - Culvert Outlet



C3b - Typical Stream Channel

| REF. | NO.  | B-2 |  |
|------|------|-----|--|
| N L  | 110. | D-E |  |

| DATE: 10    | /26/87 DATA BY: Bill Howard, James Bryant                             |
|-------------|---|
| STREAM:     | Camp Creek ODF&W REP.: Ken Witty                                      |
| LOCATION:   | 1.75 miles from Imnaha on Road 380, Wallowa County, TIN, R48E,        |
|             | Section 20  |
| TYPE OF I   | NSTALLATION: Corrugated Metal Pipe                                    |
| DIMENSION   | S: SPAN RISE DIAM. 8.0'   |
|             | LENGTH 96.3'  |
|             | GRADIENT 0.0249 foot/foot   |
| SPECIAL F   | EATURES: Fish baffles on approximately 15 foot spacings.              |
| EVALUATIO   | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                           |
| 1.          | TYPE AND CONDITION OF SPECIES: Summer steelhead trout/migratory       |
|             | and resident rainbow trout.   |
| 2.          | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                        |
|             | CRITICAL X MODERATE NONCRITICAL                                       |
| 3.          | EVALUATION OF INSTALLATION:   |
|             | GOOD FAIR X POOR  |
| 4.          | COMMENTS: There was approximately a 3.5 foot drop at the downstream   |
| end         | of this culvert on 11/8/88. It appears that this installation would   |
| bloc        | k upstream fish passage, but we know that adult steelhead make it up  |
| Camp        | Creek to spawn in the spring. This is one of our index streams for    |
| stee        | Thead spawning surveys and we have had good counts above this culvert |
| <u>in r</u> | ecent years.  |
| Ther        | e is a deep pool below the outlet of this culvert which probably      |
| <u>allo</u> | ws the fish to jump into the culvert. There also would be less drop   |
| from        | this culvert in the spring when flows are higher in Big Sheep         |
| Cree        | ek  |
|             |   |

| REF. NO. B-2 |
|--------------|
|--------------|

#### EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ۱. | CULVERT CONDITION:                               |
|----|--|
|    | GOOD FAIR X POOR                                 |
| 2. | CULVERT CAPACITY:                                |
|    | GOOD FAIR POOR _X                                |
| 3. | TYPE OF CULVERT FOUNDATION:                      |
|    | METAL FOOTING CONCRETE FOOTING CLOSED X          |
| 4. | CONDITION OF FOUNDATION:                         |
|    | GOOD X FAIR POOR                                 |
| 5. | OUTLET SCOUR:                                    |
|    | SEVERE X MODERATE NEGLIGIBLE                     |
| 6. | CULVERT STREAM SURFACE:                          |
|    | METAL X CONCRETE NATURAL                         |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS: |
|    | COMPATIBLE X INCOMPATIBLE                        |

8. COMMENTS: A larger culvert should be installed at this site to reduce potential flood damage to the roadway, to reduce barrel velocities prohibitive to fish passage, and to reduce the potential for outlet scour. The replacement culvert should be oversized and set below the existing stream bed elevation to provide a natural stream bed surface with gravels and boulders. The scour hole at the existing outlet should also be filled with gravels and boulders to provide a smooth transition from the Big Sheep Creek channel to the culvert outlet. With this type of in stallation, fish impediment due to high barrel velocities and an excessive vertical drop at the outlet would be significantly reduced to acceptable levels. At this time the backwater from the adjacent Big Sheep Creek possibly reduces the outlet culvert velocities and the vertical outlet drop during high flows. This would explain the passage of fish through the existing installation.



B2a - Culvert Outlet



B2b - Typical Stream Channel

| DATE: 10/  | 23/87 DATA BY: Bill Howard, James Bryant  |
|------------|---|
| STREAM: DO | oe Creek ODF&W REP.: Ken Witty  |
| LOCATION:  | 35 miles northeast of Enterprise, Wallowa National Forest,  |
|            | Wallowa County; T3N, R46E, Section 14   |
| TYPE OF IN | STALLATION: Corrugated Metal Pipe-Arch  |
| DIMENSIONS | : SPAN RISE DIAM  |
|            | LENGTH66.6'   |
|            | GRADIENT 0.0255 foot/foot   |
| SPECIAL FE | ATURES: Log weirs and gabions placed at outlet  |
| EVALUATION | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:   |
| 1.         | TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory   |
| ,          | and resident rainbow trout.   |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:  |
|            | CRITICAL MODERATE _X NONCRITICAL  |
| 3.         | EVALUATION OF INSTALLATION:   |
|            | GOOD FAIR _X POOR _X  |
| 4.         | Fair during high flows, poor during low flows.<br>COMMENTS: Doe Creek was dry when I inspected this culvert on 11/8/88. |
|            | It appears that this culvert was not set deep enough when the road  |
|            | was constructed and the weirs and gabions below the culvert were  |
|            | installed in an attempt to elevate the stream bed. The weirs are  |
|            | barriers to upstream and downstream passage at low flows.   |
|            | Downstream passage is a concern in these small streams because many   |
|            | of them function as nursery streams. Adult fish enter the streams   |
|            | and spawn soon after flows peak in the spring. The juvenile fish  |
|            | that hatch in these streams will often migrate to higher order  |
|            | streams in late summer or fall, when flows are low, to escape high  |
|            | temperatures or to seek suitable over-winter habitat. It appears  |
|            | that this installation would do a fair job of passing fish during   |
|            | high flows (spawning), but would not pass fish at low flows.  |

## EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR POOR   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL X CONCRETE NATURAL  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE INCOMPATIBLEX  |
|    |   |
| 8. | COMMENTS: A culvert with a rise and span comparable to the existing       |
|    | facility could be easily installed with a depressed invert. The           |
|    | depressed invert could be covered with small boulders and natural stream  |
|    | bed materials. This type of facility would significantly reduce culvert   |
|    | velocities and provide flow characteristics similar to the natural stream |
|    | channel. If weirs are maintained at the site, they should be designed to  |
|    | allow passage of fish during low flow periods by providing flow depths    |
|    | and widths comparable to the natural channel. Also, the water should be   |
|    | prevented from flowing under or through the weirs (i.e., permeable rock   |
|    | gabions.  |



C4a - Culvert Outlet



C4b - Typical Stream Channel

| REF. | NO. | D-8 |  |
|------|-----|-----|--|
|      |     |     |  |

| DATE: 10/27/87 DATA BY: Bill Howard, James Bryant                    |         |
|--|---------|
| STREAM: Gumboot Creek ODF&W REP.: Ken Witty                          |         |
| LOCATION: Southeast of Joseph on 39 Road, Wallowa County; T4S, R48E, |         |
| Section 31   |         |
| TYPE OF INSTALLATION: Structural Plate Arch                          |         |
| DIMENSIONS: SPAN 15.0' RISE 8.5' DIAM.                               |         |
| LENGTH 69.0'   |         |
| GRADIENT 0.0174 foot/foot  |         |
| SPECIAL FEATURES: Open bottom arch                                   |         |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                 |         |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migr      | atory _ |
| resident rainbow trout, bull trout                                   |         |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                    |         |
| CRITICAL X MODERATE NONCRITICAL                                      |         |
| 3. EVALUATION OF INSTALLATION:                                       |         |
| GOOD X FAIR POOR POOR  |         |
| 4. COMMENTS:   |         |
|  |         |
|  |         |
|  |         |
|  |         |

| REF. NO. | D-8 |  |
|----------|-----|--|
|----------|-----|--|

## EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR _X POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING _X CLOSED                                |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POOR _X   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLE _X   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURALX   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                        |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: A pipe-arch with a depressed metal invert could easily be     |
|    | installed at this site without altering the positive fish passage       |
|    | characteristics. While reducing the possibility of structural failure   |
|    | due to scour undermining. The depressed invert should be covered with   |
|    | stream bed materials similar to those located within the existing arch. |
|    | This measure would ensure depth and velocity characteristics similar to |
|    | the natural stream channel.   |



D8a - Culvert Inlet



D8b - Typical Stream Channel

| R  | EF. | NO. | 15-D  |
|----|-----|-----|-------|
| ٠, |     |     | , , , |

|  | REF. | NO. | 15-D |  |
|--|------|-----|------|--|
|--|------|-----|------|--|

## EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ۱. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR _X POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTINGX CLOSED                                   |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR POORX  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLE X   |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE INCOMPATIBLE  |
| 8. | COMMENTS: A pipe-arch with a depressed metal invert could easily be      |
|    | installed at this site without altering the positive fish passage        |
|    | characteristics while reducing the possibility of structural failure due |
|    | to scour undermining. The depressed invert should be covered with stream |
|    | bed materials similar to those located within the existing arch. This    |
|    | measure would ensure the depth and velocity characteristics similar to   |
|    | the natural stream hed.  |



15Da - Culvert Outlet



15Db - Typical Stream Channel

| REF. | NO. | 15-E |  |
|------|-----|------|--|
|      |     |      |  |

| DATE: 11/  | DATA BY: Bill Howard, James Bryant                                   |
|------------|--|
| STREAM: 0  | Chesnimus Creek ODF&W REP.: Ken Witty                                |
| LOCATION:  | Near Enterprise, Wallowa County; T3N, R47E, Section 21               |
|            |  |
| TYPE OF IN | ISTALLATION: Structural Plate Arch                                   |
| DIMENSIONS | S: SPAN 11.0' RISE 5.7' DIAM.  |
|            | LENGTH49.7'  |
|            | GRADIENT 0.001 foot/foot   |
| SPECIAL FE | ATURES: Open bottom arch   |
| EVALUATION | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                            |
| 1.         | TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory    |
|            | and resident rainbow trout   |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|            | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.         | EVALUATION OF INSTALLATION:  |
|            | GOOD X FAIR POOR POOR  |
| 4.         | COMMENTS: Stream flow was intermittent when I inspected this culvert |
|            | on 11/8/88.  |
|            | This culvert is on Chesnimus Creek at the mouth of Vance Draw.       |

| KEF. NU. 15-E | REF. | NO. | 15-E |  |
|---------------|------|-----|------|--|
|---------------|------|-----|------|--|

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|------------|----|---------|--------------|----|-------|------------|

| ۱. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR _X POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR X POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                  |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR POOR _X  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| •  |  |
| 8. | COMMENTS: A pipe-arch with a depressed metal invert could easily be      |
|    | installed at this site without altering the positive fish passage        |
| ,  | characteristics while reducing the possibility of structural failure due |
|    | to scour undermining. The depressed invert should be covered with stream |
|    | bed materials similar to those located within the existing arch. This    |
|    | measure would ensure depth and velocity characteristics similar to the   |
|    | natural steam channel.   |



15Ea - Culvert Inlet



15Eb - Typical Stream Channel

| REF. NO. 15-F |  |
|---------------|--|
|---------------|--|

| DATE: 11/4/87 DATA BY: Bill Howard, James Bryant                            |
|---|
| STREAM: Crow Creek ODF&W REP.: Ken Witty                                    |
| LOCATION: Northeast of Joseph on 46 Road, Wallowa County, T3N, R45E,        |
| Section 35  |
| TYPE OF INSTALLATION: Structural Plate Arch                                 |
| DIMENSIONS: SPAN 12.8' RISE 5.0' DIAM.                                      |
| LENGTH  |
| GRADIENT 0.012 foot/foot  |
| SPECIAL FEATURES: Open bottom arch. Another pipe is located at the site for |
| flood relief. The additional pipe is 4 foot diameter, corrugated steel pipe |
| with no special features for fish passage.                                  |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory        |
| and resident rainbow trout  |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                           |
| CRITICAL X MODERATE NONCRITICAL   |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD X FAIR POOR  |
| 4. COMMENTS:  |
|   |
|   |
|   |
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| REF.  | NO. | 15-F |
|-------|-----|------|
| 1,000 | 110 |      |

|  | EVALUATION | 0F | CULVERT | INSTALLATION | BY | WFLHD | PERSONNEL |
|--|------------|----|---------|--------------|----|-------|-----------|
|--|------------|----|---------|--------------|----|-------|-----------|

| ۱. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR POOR _X  |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                  |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE INCOMPATIBLE  |
| 8. | COMMENTS: In general, this is a good culvert installation. However, if   |
|    | the arch could be replaced, it should be replaced with an installation   |
|    | that would reduce the HW/rise ratio to 1.5 during a 50 year flood event. |
|    | This would reduce the potential of flood damage to the road due to flood |
|    | overtopping and debris clogging.   |



15Fa - Culvert Inlet



15Fb - Typical Stream Channel

| REF. NO. 13-A | Ri | EF. | NO. | 13-A |
|---------------|----|-----|-----|------|
|---------------|----|-----|-----|------|

| DATE: 11/8/87 DATA BY: Bill Howard, James Bryant                              |
|---|
| STREAM: Meacham Creek ODF&W REP.: Jim Phelps                                  |
| LOCATION: 0.2 mile north of Meacham on main railroad line just east of old    |
| US 30 (MP 239), Umatilla County, T1S, R35E, Section 3                         |
| TYPE OF INSTALLATION: Structural Plate Pipe                                   |
| DIMENSIONS: SPAN 12.8' RISE 14' DIAM.   |
| LENGTH 120'   |
| GRADIENT 0.013 foot/foot  |
| SPECIAL FEATURES: Culvert appears to be depressed below the natural stream    |
| bed. Another pipe is located at the site for flood relief. The additional     |
| pipe is a 10 foot rise by 8.8 foot span, corrugated steel pipe with no specia |
| features for fish passage.  |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident trout            |
|   |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                             |
| CRITICAL MODERATE X NONCRITICAL   |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD FAIR X POOR  |
| 4. COMMENTS: Adult steelhead spawn upstream from this culvert.                |
|   |
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|------|-----|------|--|
| REF. | NU. | 13-A |  |

| <u>ev</u> alu | JATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:                  |
|---------------|---|
| 1.            | CULVERT CONDITION:  |
|               | GOOD X FAIR POOR  |
| 2.            | CULVERT CAPACITY:   |
|               | GOOD X FAIR POOR POOR   |
| 3.            | TYPE OF CULVERT FOUNDATION:   |
|               | METAL FOOTING CONCRETE FOOTING CLOSEDX                              |
| 4.            | CONDITION OF FOUNDATION:  |
|               | GOOD X FAIR POOR POOR   |
| 5.            | OUTLET, SCOUR:  |
|               | SEVERE MODERATE NEGLIGIBLEX   |
| 6.            | CULVERT STREAM SURFACE:   |
|               | METAL CONCRETE NATURALX   |
| 7.            | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                    |
|               | COMPATIBLE X INCOMPATIBLE   |
| 8.            | COMMENTS: Since the main culvert is depressed 2 to 3 feet below the |

8. COMMENTS: Since the main culvert is depressed 2 to 3 feet below the natural stream bed, small boulders, cobbles, and gravels have been placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage features.



13Aa - Culvert Outlet



13Ab - Typical Stream Channel

| MEI # 110# 10 D | REF. NO. 13-B |  |
|-----------------|---------------|--|
|-----------------|---------------|--|

| DATE: 11/8  | DATA BY: Bill Howard, James Bryant                                   |
|-------------|--|
| STREAM: Me  | acham Creek ODF&W REP.: Jim Phelps                                   |
| LOCATION:   | 1.0 mile north of Meacham on main railroad line just east of         |
|             | old US 30 (MP 239), Umatilla County; TlN, R35E, Section 35           |
| TYPE OF INS | TALLATION: Structural Plate Pipe                                     |
| DIMENSIONS: | SPAN RISE DIAM. 15'  |
|             | LENGTH 143'  |
|             | GRADIENT 0.013 foot/foot   |
| SPECIAL FEA | ATURES: Culvert appears to be depressed below the natural stream     |
| bed. Anoth  | ner pipe is located at the site for flood relief. The additional     |
| pipe is a l | O foot diameter, corrugated steel pipe with no special features for  |
| fish passag | ge.  |
| EVALUATION  | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                            |
| 1.          | TYPE AND CONDITION OF SPECIES: Summer steelhead, resident trout      |
| _           |  |
| 2.          | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
| (           | CRITICAL MODERATE X NONCRITICAL                                      |
| 3. i        | EVALUATION OF INSTALLATION:  |
| (           | GOOD FAIR X POOR   |
| 4.          | COMMENTS: We are not aware of any passage problems at this location. |
| _           |  |
| _           |  |
|             |  |
|             |  |
|             |  |

| REF. | NO. | 13 <b>-</b> B |  |
|------|-----|---------------|--|
|      |     |               |  |

# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ۱. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURALX   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: Since the main culvert is depressed be 2 to 3 feet below the    |
|    | natural stream bed; small boulders, cobbles, and gravels have been placed |
|    | within the culvert barrel without significantly restricting the natural   |
|    | stream flow. This installation, thus, provides velocity and depth         |
|    | characteristics similar to the natural stream channel. In general, this   |
|    | is a good installation from the perspective of the highway facility and   |
|    | in terms of fish passage features.  |



13Ba - Culvert Inlet



13Bb - Typical Channel Section

| REF. NO. 13-C |  |
|---------------|--|
|---------------|--|

| DATE: 10/8/87                       | DATA BY: Bill Howard, James Bryant                 |
|-------------------------------------|--|
| STREAM: Meacham Creek               | ODF&W REP.: Jim Phelps                             |
| LOCATION: 1.1 miles north of        | Meacham on main railroad line just east of old     |
| US 30 (MP 239), Um                  | natilla County; TlN, R35E, Section 35              |
| TYPE OF INSTALLATION: <u>Struct</u> | tural Plate Pipe-Oval                              |
| DIMENSIONS: SPAN 14'                | RISE 15' DIAM.                                     |
| LENGTH 135                          | 5' <u> </u>  |
| GRADIENT 0.0                        | D2O foot/foot                                      |
| SPECIAL FEATURES: Culvert ap        | opears to be depressed below the natural stream    |
|                                     | d at the site for flood relief. The additional     |
|                                     | corrugated steel pipe with no special features for |
| fish passage.                       |  |
| EVALUATION OF PASSAGE FACILITY      | TIES BY ODF&W PERSONNEL:                           |
| 1. TYPE AND CONDITION               | OF SPECIES: Summer steelhead, resident rainbow     |
| trout                               | <u> </u>   |
| 2. IMPORTANCE OF INSTA              | ALLATION TO SUBJECT SPECIES:                       |
|                                     | DDERATE X NONCRITICAL                              |
| 3. EVALUATION OF INSTA              |  |
| GOOD FAIR _                         |  |
|                                     | re of any passage problems.                        |
| 1. OOTHER 13. HOE GAR               | re or any passage problems.                        |
| <del>-</del>                        |  |
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| REF. | NO. | 13-C |  |
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|      |     |      |  |

#### EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ١. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: Since the main culvert is depressed 2 to 3 feet below the       |
|    | natural stream bed; small boulders, cobbles, and gravels have been placed |
|    | within the culvert barrel without significantly restricting the natural   |
|    | stream flow. This installation, thus, provides velocity and depth         |
|    | characteristics similar to the natural stream channel. In general, this   |
|    | is a good installation from the perspective of the highway facility and   |
|    | in terms of fish passage features.  |



13Ca - Culvert Barrel



13Cb - Typical Stream Channel

| R | EF |  | NO. | 1 | 3-D |
|---|----|--|-----|---|-----|
|---|----|--|-----|---|-----|

| DATE: 11/7/87 DATA BY: Bill Howard, James Bryant                            |
|---|
| STREAM: Meacham Creek ODF&W REP.: Jim Phelps                                |
| LOCATION: 1.4 miles north of Meacham on main railroad line just east of old |
| US 30 (MP 239), Umatilla County, TIN, R35E, Section 35                      |
| TYPE OF INSTALLATION: Structural Plate Pipe-Oval                            |
| DIMENSIONS: SPAN 20' RISE 20' DIAM.   |
| LENGTH 160'   |
| GRADIENT 0.014 foot/foot  |
| SPECIAL FEATURES: Culvert appears to be depressed below the natural stream  |
| bed. The culvert is connected to a 25 foot long, single span bridge.        |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident rainbow        |
| trout   |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                           |
| CRITICAL MODERATE X NONCRITICAL   |
| 3. EVALUATION OF INSTALLATION:  |
| GOOD X FAIR POOR  |
| 4. COMMENTS:  |
|   |
|   |
|   |
|   |

| REF. NO. | 13-D |
|----------|------|
|----------|------|

# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ì. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                   |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: Since the culvert is depressed 3 to 5 feet below the natural   |
|    | stream bed, small boulders cobbles, and gravels have been placed within  |
|    | the culvert barrel without significantly constricting the natural stream |
|    | flow. This installation, thus, provides velocity and depth               |
|    | characteristics similar to the natural stream channel. In general, this  |
|    | is a good installation from the perspective of the highway facility and  |
|    | in terms of the fish passage features.                                   |



13Da - Culvert Barrel



13Db - Typical Stream Channel

|  | REF. | NO. | 13-E |  |
|--|------|-----|------|--|
|--|------|-----|------|--|

| ATE: 11/6/87 DATA BY: Bill Howard, James Bryant                            |
|--|
| TREAM: Sheep Creek ODF&W REP.: Jim Phelps                                  |
| OCATION: 1.5 miles north of Meacham on main railroad lone just east of old |
| US 30 (MP 239), Umatilla County, TlN, R35E, Section 35                     |
| YPE OF INSTALLATION: Concrete Underpass and Corrugated Metal Pipe          |
| IMENSIONS: SPAN RISE DIAM. 7'  |
| LENGTH 124'  |
| GRADIENT 0.053 foot/foot   |
| PECIAL FEATURES: None. 8.0 foot span by 8.5 foot rise. Concrete underpass  |
| connects to a 7 foot diameter corrugated metal pipe.                       |
| VALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1. TYPE AND CONDITION OF SPECIES: Probable summer steelhead, resident      |
| rainbow trout  |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                          |
| CRITICAL MODERATE X NONCRITICAL  |
| 3. EVALUATION OF INSTALLATION:   |
| GOOD FAIR POOR X   |
| 4. COMMENTS: Gradient between culvert and Meacham Creek is steep and       |
| rocky due to railroad construction.  |
|  |
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SHEET 2 OF 3

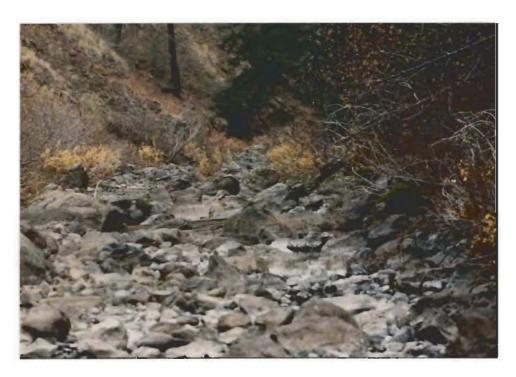
REF. NO. 13-E

| EVALUATION ( | )F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|--------------|----|---------|--------------|----|-------|------------|
|--------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX_  |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL X CONCRETE NATURAL   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:   |
|    | COMPATIBLE INCOMPATIBLEX   |
| •  | COMMENTO TO THE PROPERTY OF TH |
| 8. | COMMENTS: If passage were required at this site, a culvert with rise a   |
|    | and span comparable to the existing facility could be easily installed   |
|    | with a depressed invert. The depressed invert could be covered with  |
|    | small boulders and natural stream bed materials. This type of facility   |
|    | would significantly reduce culvert velocities and provide flow   |
|    | characteristics similar to the natural stream channel.   |



13Ea - Culvert Outlet



13Eb - Typical Stream Channel

| REF. NO. 12-A |
|---------------|
|---------------|

| DATE: <u>11/</u> 1 | 2/87 DATA BY: Bill Howard, James Bryant                            |
|--------------------|--|
| STREAM: _Ca        | anyon Creek ODF&W REP.: Errol Claire                               |
| LOCATION:          | Canyon Creek near Wickiup Campground, Grant County; T16S, R32E,    |
|                    | Section 2  |
| TYPE OF IN         | STALLATION: Structural Plate Pipe-Arch                             |
| DIMENSIONS         | : SPAN 12.6' RISE 8.1' DIAM.                                       |
|                    | LENGTH   |
|                    | GRADIENT 0.020 foot/foot   |
| SPECIAL FE         | ATURES: None.  |
| EVALUATION         | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.                 | TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults   |
| <u>.</u>           | and juveniles  |
| 2.                 | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                     |
| •                  | CRITICAL X MODERATE NONCRITICAL                                    |
| 3.                 | EVALUATION OF INSTALLATION:  |
| I                  | GOOD FAIR X POOR   |
| 4.                 | COMMENTS: Grade too high - pipe not set deep enough - necessitates |
| :                  | a rock weir downstream to provide better passage.                  |
| _                  |  |
| _                  |  |
|                    |  |
|                    |  |

SHEET 2 OF 3

REF. NO. 12-A

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|            |    |         |              |    |       |            |

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR POOR   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD FAIR X POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD X FAIR POOR POOR   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE X MODERATE NEGLIGIBLE  |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL X CONCRETE NATURAL  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE INCOMPATIBLE _X  |
| 8. | COMMENTS: If the culvert were to be replaced in the future, the culvert   |
|    | should be oversized and installed with natural stream bed materials such  |
|    | as gravels and small boulders. This type of facility would significantly  |
|    | reduce culvert velocities and provide flow characteristics similar to the |
|    | natural stream channel.   |

REF. NO. 12-A



12Aa - Culvert Outlet



12Ab - Typical Stream Channel

| REF. | NO. | 12 <b>-</b> B |  |
|------|-----|---------------|--|
|------|-----|---------------|--|

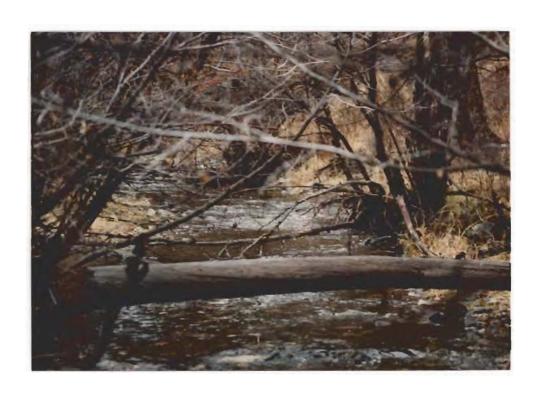
| REF. NO. | 12-B |
|----------|------|
|----------|------|

|  | VALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|--|-----------|----|---------|--------------|----|-------|------------|
|--|-----------|----|---------|--------------|----|-------|------------|

| ۱. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSED X                                  |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR POOR  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: Since the culvert is depressed 2 to 3 feet below the natural   |
|    | stream bed, small boulders, cobbles, and gravels have been placed within |
|    | the culvert barrel without significantly restricting the natural stream  |
|    | flow. This installation, thus, provides velocity and depth               |
|    | characteristics similar to the natural stream channel. In general, this  |
|    | is a good installation from the perspective of the highway facility and  |
|    | in terms of fish passage features.                                       |



12Ba - Culvert Inlet



12Bb - Typical Stream Channel

| REF. NO. | 12-C |
|----------|------|
|----------|------|

| DATE: <u>11</u>                                   | /12/87 DATA BY: Bill Howard, James Bryant                          |  |
|---|--|--|
| STREAM:   | Canyon Creek ODF&W REP.: Errol Claire                              |  |
| LOCATION:   | Canyon Creek at junction of US Roads 15 and 1520, Grant County;    |  |
|   | T16S, R32E, Section 1  |  |
| TYPE OF I   | NSTALLATION: Structural Plate Pipe                                 |  |
| DIMENSIONS: SPAN RISE DIAM. 10'                   |  |  |
|   | LENGTH 113'  |  |
|   | GRADIENT 0.0177 foot/foot  |  |
| SPECIAL F   | EATURES: Culvert appears to be depressed below the natural stream  |  |
| bed.  |  |  |
|   | ON OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                       |  |
| 1.  | TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/cutthroat/chinook |  |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES: |  |  |
|   | CRITICAL X MODERATE NONCRITICAL                                    |  |
| 3.  | EVALUATION OF INSTALLATION:  |  |
|   | GOOD X FAIR POOR   |  |
| 4.  | COMMENTS:  |  |
|   |  |  |
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| EVALUATION OF CULVERT INSTALLATION BY WFLHD PER | VALUATION O | CULVERT | INSTALLATION | BY | WFLHD | PERSONNEL: |
|---|-------------|---------|--------------|----|-------|------------|
|---|-------------|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR _X POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX                                   |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR POOR  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: Since the culvert is depressed approximately 1 foot below the  |
|    | natural stream bed, small boulders, cobbles, and gravels have been       |
|    | periodically placed within the culvert barrel without significantly      |
|    | restricting the natural stream flow. This installation, thus, provides   |
|    | velocity and depth characteristics similar to the natural stream         |
|    | channel. In general, this is a good installation from the perspective of |
|    | the highway facility and in terms of fish passage characteristics.       |



12Ca - Culvert Barrel



12Cb - Typical Stream Channel

| REF. NO. 12- | -D |
|--------------|----|
|--------------|----|

| DATE: 11/  | /17/87 DATA BY: Bill Howard, James Bryant                            |
|------------|--|
| STREAM: E  | Ruby Creek ODF&W REP.: Errol Claire                                  |
| LOCATION:  | Middle Fork John Day River Road, Grant County; T115, R34E, Section 6 |
| TYPE OF IN | NSTALLATION: Corrugated Metal Arch                                   |
| DIMENSIONS | S: SPAN 8' RISE 4' DIAM.   |
|            | LENGTH60'  |
|            | GRADIENT 0.030 foot/foot   |
| SPECIAL F  | EATURES: Open bottom arch  |
| EVALUATIO  | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.         | TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook,            |
|            | adults and juveniles   |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|            | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.         | EVALUATION OF INSTALLATION:  |
|            | GOOD X FAIR POOR   |
| 4.         | COMMENTS:  |
|            | · · · · · · · · · · · · · · · · · · ·                                |
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|            |  |
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| REF.    | NO.  | 12-D |  |
|---------|------|------|--|
| L/ La 1 | 110. | 12-0 |  |

## EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR X POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR X POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLE X   |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL _X  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                       |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: In general, this is a good culvert installation. However, a  |
|    | pipe-arch could have been installed at this site. With a pipe arch,    |
|    | foundation does not have to be set on bedrock or below the scour depth |
|    | for large flood events.  |



12Da - Culvert Outlet



12Db - Typical Stream Channel

| REF. NO. | 12-E |
|----------|------|
|----------|------|

SHEET 2 OF 3

REF. NO. 12-E

| EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSO | EVALUATION | OF CULVERT | INSTALLATION | BY | WELHD | PERSONNEL |
|---|------------|------------|--------------|----|-------|-----------|
|---|------------|------------|--------------|----|-------|-----------|

| ١. | CULVERT CONDITION:  |
|----|---|
| •  |   |
|    | GOOD FAIR POOR _X   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD FAIR X POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED   |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POOR _X   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE X NEGLIGIBLE  |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:  |
|    | COMPATIBLE X INCOMPATIBLE   |
| 0  | COMPAGNITO TO THE PART OF THE |
| 8. | COMMENTS: The existing arch should be replaced with an oversized struc-   |
|    | tural plate pipe. The pipe invert could be set below the existing stream  |
|    | gradient and backfilled with natural stream bed material. This  |
|    | alternative would provide the same positive fish passage characteristics  |
|    | as the existing facility while eliminating the possibility of scour   |
|    | failure that currently exists at the site. Also, boulder clusters or log  |
|    | weirs may be required to reduce culvert velocities at the pipe outlet.  |



12Ea - Culvert Barrel



12Eb - Typical Stream Channel

| REF. NO. | 12-F |
|----------|------|
|----------|------|

| DATE: <u>11</u> | /18/87 DATA BY: Bill Howard, James Bryant                           |
|-----------------|---|
| STREAM:         | Indian Creek ODF&W REP.: Errol Claire                               |
| LOCATION:       | Middle Fork John Day Road, Grant County; T9S, R32E, Section 7       |
| TYPE OF I       | INSTALLATION: Structural Plate Arch                                 |
| DIMENSION       | NS: SPAN 12' RISE 7' DIAM.  |
|                 | LENGTH  |
|                 | GRADIENT 0.034 foot/foot  |
| SPECIAL F       | FEATURES: Open bottom arch  |
| EVALUATIO       | ON OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                        |
| 1.              | TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adult and |
|                 | juveniles   |
| 2.              | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                      |
|                 | CRITICAL X MODERATE NONCRITICAL                                     |
| 3.              | EVALUATION OF INSTALLATION:   |
|                 | GOOD X FAIR POOR  |
| 4.              | COMMENTS:   |
| •               |   |
|                 |   |
|                 |   |
|                 |   |
|                 |   |

| REF.            | NO. | 12-F |  |
|-----------------|-----|------|--|
| ( <b>\</b> _1 • |     | 16.  |  |

| EVALUATION | 0F | CULVERT | INSTALLATION | ВΥ | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR POORX   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD FAIR X POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                 |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POORX   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATEX NEGLIGIBLE   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL X  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                        |
|    | COMPATIBLE X INCOMPATIBLE   |
| •  | COMMENTS. The eviction such should be wenleded with an every            |
| 8. |   |
|    | structural plate pipe. The pipe invert should be set below the existing |
|    | stream bed gradient and backfilled with natural stream bed material.    |
|    | This alternative would provide the same positive fish passage           |
|    | characteristics as the existing facility while eliminating the          |
|    | possibility of scour failure that currently exists at the site. Also,   |
|    | boulder clusters or log weirs may be required to reduce culvert         |
|    | velocities at the pipe outlet.  |



12Fa - Culvert Outlet



12Fb - Typical Stream Channel

| RE. | F. | NO. | 12- | G |
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| REF. | NO. | 12-G |  |
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| EVALUATION ( | 0F | CULVERT | INSTALLATION | ВΥ | WFLHD | PERSONNEL: |
|--------------|----|---------|--------------|----|-------|------------|
|--------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR X POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING _X _ CLOSED                               |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR POOR _X  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL _X  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: If the existing arch footings are not set on bedrock, then the |
|    | arch should be replaced with an oversized structural plate pipe or       |
|    | pipe-arch. The pipe invert should be set below the existing stream bed   |
|    | gradient and backfilled with natural stream bed material. This           |
|    | alternative would provide the same positive fish passage characteristics |
|    | as the existing facility while eliminating the possibility of scour      |
|    | failure that currently exists at the site.                               |



12Ga - Culvert Barrel



12Gb - Typical Stream Channel

| REF. | NO. | 12-H           |
|------|-----|----------------|
|      |     | , <del>-</del> |

| DATE: <u>11</u> | /18/87 DATA BY: Bill Howard, James Bryant                            |
|-----------------|--|
| STREAM:         | Granite Creek ODF&W REP.: Errol Claire                               |
| LOCATION:       | US 395, Grant County; T8S, R31E, Section 17                          |
|                 |  |
| TYPE OF I       | NSTALLATION: Structural Plate Arch                                   |
| DIMENSION       | S: SPAN 13.1' RISE 6.8 feet" DIAM.                                   |
|                 | LENGTH 72'   |
|                 | GRADIENT 0.015 foot/foot   |
| SPECIAL F       | FEATURES: Open bottom arch   |
| EVALUATIO       | ON OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                         |
| 1.              | TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and |
|                 | juveniles  |
| 2.              | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|                 | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.              | EVALUATION OF INSTALLATION:  |
|                 | GOOD X FAIR POOR POOR  |
| 4.              | COMMENTS:  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |

SHEET 2 OF 3
REF. NO. 12-H

| EVALUATION | 0F | CULVERT | INSTALLATION | ВΥ | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|------------|----|---------|--------------|----|-------|------------|

| ١. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR X POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTINGX CLOSED                                   |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR POOR _X  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL _X  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: The arch should be replaced with an oversized structural plate |
| ٥. |  |
|    | pipe or pipe-arch. The pipe invert should be set below the existing      |
|    | stream bed gradient and backfilled with natural stream bed material.     |
|    | This alternative would provide the same positive fish passage            |
|    | characteristics as the existing facility while eliminating the           |
|    | possibility of scour failure that currently exists at the site.          |



12Ha - Culvert Barrel



12Hb - Typical Stream Channel

| REF. NO. | 12-I |
|----------|------|
|----------|------|

| DATE: 11/19/87 DATA 9                          | Y: Bill Howard, James E | ryant                                 |
|--|-------------------------|---------------------------------------|
| STREAM: Granite Creek                          | ODF&W REP.: Errol Cla   | ire                                   |
| LOCATION: US 395, Grant County; T8S            | R31E, Section 30        |                                       |
| TYPE OF INSTALLATION: Structural Plan          | te Arch                 |                                       |
| DIMENSIONS: SPAN 13.2'                         |                         |                                       |
| LENGTH111'                                     |                         |                                       |
| GRADIENT 0.022 foot/                           | oot                     |                                       |
| SPECIAL FEATURES: Open bottom arch             |                         |                                       |
| EVALUATION OF PASSAGE FACILITIES BY            | DF&W PERSONNEL:         |                                       |
| 1. TYPE AND CONDITION OF SPEC                  | ES: Rainbow/steelhead/o | chinook, adults and                   |
| juveniles                                      |                         |                                       |
| 2. IMPORTANCE OF INSTALLATION                  | TO SUBJECT SPECIES:     |                                       |
| CRITICAL X MODERATE                            | NONCRITICAL             | _                                     |
| <ol> <li>EVALUATION OF INSTALLATION</li> </ol> |                         |                                       |
| GOOD X FAIR                                    | 900R                    |                                       |
| 4. COMMENTS:                                   |                         | · · · · · · · · · · · · · · · · · · · |
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SHEET 2 OF 3

| REF. | NO. | 12-I |
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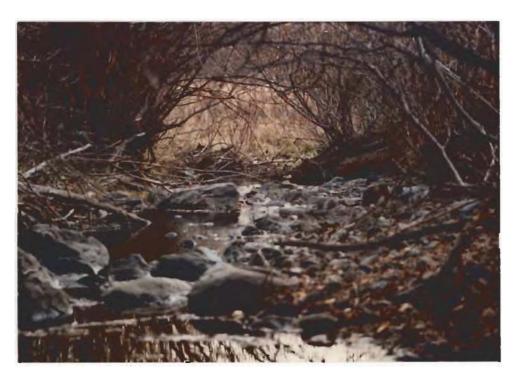
# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ١. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR POOR _X   |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTINGX CLOSED                                    |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR POOR _X   |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: The arch should be replaced with an oversized structural plate_ |
| ٠, | pipe or pipe-arch. The pipe invert should be set below the existing       |
|    |   |
|    | stream bed gradient and backfilled with natural stream bed material. This |
|    | alternative would provide the same positive fish passage characteristics  |
|    | as the existing facility while eliminating the possibility of scour       |
|    | failure that currently exists at the site.                                |

REF. NO. 12-I



12Ia - Culvert Barrel



12Ib - Typical Stream Channel

| REF. | NO. | 12-J |
|------|-----|------|
| .,   |     |      |

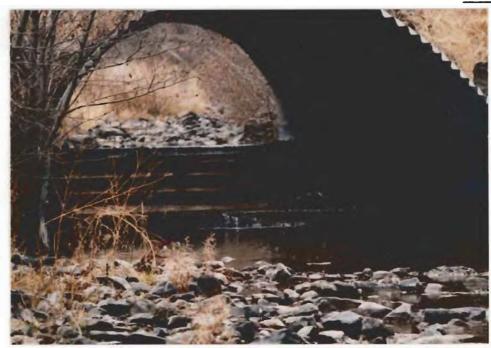
| DATE: 11/  | /22/87 DATA BY: Bill Howard, James Bryant                          |
|------------|--|
| STREAM: S  | Sunflower Creek ODF&W REP.: Errol Claire                           |
| LOCATION:  | 15 miles east of Paulina, Grant County; T16S, R27E, Section 19     |
|            |  |
| TYPE OF IN | ISTALLATION: Structural Plate Pipe-Arch                            |
| DIMENSIONS | S: SPAN 17.3' RISE 10' DIAM.                                       |
|            | LENGTH 87'   |
|            | GRADIENT 0.037 foot/foot   |
| SPECIAL FE | EATURES: Baffles installed on 12 foot spacings                     |
| EVALUATION | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.         | TYPE AND CONDITION OF SPECIES: Wild Rainbow (Redbands), adults and |
|            | juveniles  |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                     |
|            | CRITICAL X MODERATE NONCRITICAL                                    |
| 3.         | EVALUATION OF INSTALLATION:  |
|            | GOODX FAIR POOR  |
| 4.         | COMMENTS: Must also accommodate steelhead once South Fork Falls is |
|            | laddered. Presently being reviewed by BPA.                         |
|            |  |
|            |  |
|            |  |
|            |  |

SHEET 2 OF 3

REF. NO. 12-J

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSEDX   |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR POOR  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:   |
|    | COMPATIBLE X INCOMPATIBLE  |
|    | COMMENTO. The best of the second decaded to the best of the best o |
| 8. | COMMENTS: In general, this is a good installation. The baffles aid in the  |
|    | retention of boulder, gravel, and cobble deposits within the barrel. The   |
|    | culvert barrel area is sufficient to pass wooded debris while the baffles  |
|    | do not appear to collect floating debris. Finally, the baffles appear to   |
|    | be the appropriate height for permitting fish passage during low flow  |
|    | neriods.   |



12Ja - Culvert Outlet



12Jb - Typical Stream Channel

| REF.  | NO. | 11-A |  |
|-------|-----|------|--|
| • • • |     |      |  |

| DATE: <u>11/</u> | 23/87 DATA BY: Bill Howard, James Bryant                           |
|------------------|--|
| STREAM: M        | arks Creek ODF&W REP.: Ed Schwartz                                 |
| LOCATION:        | 25 miles east of Prineville on US 26, Wheeler County; T13S, R19E,  |
|                  | Section 17   |
| TYPE OF IN       | STALLATION: Structural Plate Arch                                  |
| DIMENSIONS       | : SPAN 18' RISE 8.8' DIAM.   |
|                  | LENGTH 53'   |
|                  | GRADIENT 0.0027 foot/foot  |
| SPECIAL FE       | ATURES: Open bottom arch. Log weirs placed upstream and down-      |
| stream fro       | m culvert.   |
| EVALUATION       | OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.               | TYPE AND CONDITION OF SPECIES: Fair population of rainbow trout in |
|                  | some years when steamflows are adequate.                           |
| 2.               | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                     |
|                  | CRITICAL MODERATE X NONCRITICAL                                    |
| 3.               | EVALUATION OF INSTALLATION:  |
|                  | GOOD X FAIR POOR   |
| 4.               | COMMENTS: Conditions under this culvert resemble the natural state |
|                  | very closely.  |
|                  |  |
|                  |  |
|                  |  |
|                  |  |

SHEET 2 OF 3

REF. NO. 11-A

| EVALUATION OF | CULVERT | INSTALLATION | ВΥ | WFLHD | PERSONNEL: |
|---------------|---------|--------------|----|-------|------------|
|               |         |              |    |       |            |

| ١. | CULVERT CONDITION:  |
|----|---|
|    | GOOD X FAIR POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING X CONCRETE FOOTING CLOSED                                 |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR X POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURALX   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                        |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: The natural steam bed surface within the culvert barrel pro-  |
|    | vides depth and velocity characteristics similar to the natural stream  |
|    | channel. Thus, the fish passager characteristics are good at this site. |
|    | Overall, this is a good culvert installation.                           |
|    | · · · · · · · · · · · · · · · · · · ·                                   |
|    |   |
|    |   |
|    |   |



11Aa - Culvert Outlet



11Ab - Typical Stream Channel

| D | EF. | NΛ  | 10-A |  |
|---|-----|-----|------|--|
| К | E - | NO. | 10-7 |  |

| DATE: 11  | /23/87 DATA BY: Bill Howard, James Bryant                            |
|-----------|--|
| STREAM:   | Brown's Creek ODF&W REP.: Ted Fies                                   |
|           | Tributary to Wickiup Reservoir, Deschutes County; T21S, R8E,         |
|           | Section 29   |
| TYPE OF I | NSTALLATION: Structural Plate Pipe-Arch                              |
| DIMENSION | S: SPAN 12.6' RISE 9.4' DIAM.  |
|           | LENGTH _76'  |
|           | GRADIENT 0.005 foot/foot   |
| SPECIAL F | EATURES: Culvert appears to be depressed below the natural stream    |
| bed.      |  |
| EVALUATIO | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.        | TYPE AND CONDITION OF SPECIES: Spawning brown trout, spawnin kokanee |
| 2.        | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|           | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.        | EVALUATION OF INSTALLATION:  |
|           | GOOD X FAIR POOR   |
| 4.        | COMMENTS: The Brown's Creek arch culvert has worked extremely well.  |
|           | It poses absolutely no problems for adult fish or juvenile fish      |
|           | moving up or downstream.   |
|           |  |
|           |  |
|           |  |

SHEET 2 OF 3

REF. NO. 10-A

# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD X FAIR POOR POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING CLOSED X                                |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD X FAIR POOR POOR  |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURAL _X  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                       |
|    | COMPATIBLE X INCOMPATIBLE  |
| 0  | COMMENTS. Although some of the size invest metal is evered the flat    |
| ٥. | COMMENTS: Although some of the pipe invert metal is exposed, the flat  |
|    | gradient and the sporadic deposition of natural stream bed materials   |
|    | within the culvert barrel provide depth and velocity characteristics   |
|    | similar to the natural stream channel. Thus, the fish passage          |
|    | characteristics are good at this site. Overall, this is a good culvert |
|    | installation.  |



10Aa - Culvert Inlet



10Ab - Typical Stream Channel

| DEE  | NΩ  | 2_1 |
|------|-----|-----|
| REF. | NU. | 4-H |

| DATE: 11/27/87 DATA BY: Bill Howard, James Bryant                          |
|--|
| STREAM: Lowe Creek ODF&W REP.: Jay Massey                                  |
| LOCATION: FS Road 4671, Clackamas County; T7S, R73, Section 24             |
|  |
| TYPE OF INSTALLATION: Structural Plate Arch                                |
| DIMENSIONS: SPAN 21.7' RISE 11.7' DIAM.                                    |
| LENGTH 72'   |
| GRADIENT 0.05 foot/foot  |
| SPECIAL FEATURES: Open bottom arch with boulders placed inside the barrel. |
| EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                       |
| 1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winter     |
| steelhead. Also, resident trout in the system.                             |
| 2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                          |
| CRITICAL MODERATE NONCRITICAL  |
| *Critical for salmon and steelhead; important for resident trout.          |
| 3. EVALUATION OF INSTALLATION:   |
| GOOD X FAIR POOR   |
| 4. COMMENTS: Excellent open bottom arch installation.                      |
|  |
|  |
|  |
|  |
|  |

SHEET 2 OF 3

REF. NO. \_2-A\_\_\_\_\_

|  | EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|--|------------|----|---------|--------------|----|-------|------------|
|--|------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR _X POOR  |
| 2. | CULVERT CAPACITY:  |
|    | GOOD X FAIR POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING _X _ CLOSED                               |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR POOR X   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATEX NEGLIGIBLE  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: In general, the above culvert is a good highway and fish pass- |
|    | age installation. However, open bottom arches with shallow foundations   |
|    | are susceptible to scour if not placed on nonerodible materials (i.e.,   |
|    | bedrock). If this foundation requirement cannot be met, then a pipe      |
|    | culvert with its metal invert depressed below the natural stream bed     |
|    | gradient should be installed at these types of locations.                |
|    |  |



2Aa - Culvert Inlet



2Ab - Typical Stream Channel

| REF. | NO. | 2-B |  |
|------|-----|-----|--|
|      |     |     |  |

| DATE: 11/28/  | DATA BY: Bill Howard, James Bryant                               |
|---------------|--|
| STREAM: Poop  | Creek ODF&W REP.: Jay Massey                                     |
| LOCATION: On  | FS Road 42, east of Camp Creek Road, Clackamas County; T7S, R8E, |
| Se            | ction 9  |
| TYPE OF INSTA | LLATION: Corrugated Metal Pipe                                   |
| DIMENSIONS:   | SPAN RISE DIAM. 4'   |
|               | LENGTH 50'   |
|               | GRADIENT 0.059 foot/foot   |
| SPECIAL FEATU | RES: Man-made pools were built at inlet and outlet with log      |
| barriers.     |  |
| EVALUATION OF | PASSAGE FACILITIES BY ODF&W PERSONNEL:                           |
| 1. TYP        | E AND CONDITION OF SPECIES: We don't have good inventory infor-  |
| mat           | ion on Poop Creek. May have a few Coho salmon and winter steel-  |
| hea           | d in the stream. Resident trout are in the system.               |
| 2. IMP        | ORTANCE OF INSTALLATION TO SUBJECT SPECIES:                      |
| CRI           | TICAL X* MODERATE NONCRITICAL                                    |
|               | tical for salmon and steelhead; important for resident trout.    |
| 3. EVA        | LUATION OF INSTALLATION:   |
| G00           | D FAIR X POOR  |
|               | MENTS: Passage okay. Gradient a little steep for good fish       |
| pas           | sage.  |
|               |  |
|               |  |
|               |  |
|               |  |

| SHEET 2 | 2 OF 3        |  |
|---------|---------------|--|
| REF. NO | 0. <u>2-B</u> |  |

#### EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ١. | CULVERT CONDITION:                               |
|----|--|
|    | GOOD X FAIR POOR                                 |
| 2. | CULVERT CAPACITY:                                |
|    | GOOD X FAIR POOR                                 |
| 3. | TYPE OF CULVERT FOUNDATION:                      |
|    | METAL FOOTING CONCRETE FOOTING CLOSED _X         |
| 4. | CONDITION OF FOUNDATION:                         |
|    | GOOD X FAIR POOR                                 |
| 5. | OUTLET SCOUR:                                    |
|    | SEVERE MODERATE NEGLIGIBLE                       |
| 6. | CULVERT STREAM SURFACE:                          |
|    | METAL X CONCRETE NATURAL                         |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS: |

COMPATIBLE INCOMPATIBLE X

8. COMMENTS: The pipe metal invert and the steep pipe slope (i.e., 0.059)

foot/foot) induce stream velocities through the culvert facility that are 2 to 3 times greater than the stream velocities encountered in the natural channel cross section. Also scour was observed at the pipe outlet due to these high velocities. Thus, the pipe culvert may inhibit passage of fisheries during high runoff periods. If the culvert were to be replaced in the future, the culvert would require oversizing for the placement of baffles and/or natural stream bed materials such as gravels and small boulders to sufficiently reduce stream velocities at the culvert facility. Furthermore, the short culvert length of 50 feet may permit passage of fish under flow conditions that otherwise would not occur in a longer culvert length. Thus, if the pipe culvert is lengthened during the replacement process, the stream velocities within the culvert barrel may require further reduction to compensate for the additional length the fishery must traverse at the culvert site.



2Ba - Culvert Inlet



2Bb - Typical Stream Channel

| REF. | NO.  | 3-A |  |
|------|------|-----|--|
| VF.  | 110. | J-A |  |

| DATE: 12   | DATA BY: Bill Howard, James Bryant                                  |
|------------|---|
| STREAM: P  | Pine Creek ODF&W REP.: John Haxton                                  |
| LOCATION:  | 18 miles south of Molalla, Clackamas County; T6S, R3E, Section 27   |
|            |   |
| TYPE OF IN | NSTALLATION: Corrugated Metal Pipe                                  |
| DIMENSIONS | S: SPAN RISE DIAM7.5'   |
|            | LENGTH46'   |
|            | GRADIENT 0.026 foot/foot  |
| SPECIAL FE | EATURES: An additional 36 inch diameter pipe has been installed for |
| flood reli | ief. The flood relief pipe does not have any special features for   |
| fish passa | age.  |
| EVALUATION | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                         |
| 1.         | TYPE AND CONDITION OF SPECIES: Resident cutthroat trout             |
|            |   |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                      |
|            | CRITICAL MODERATE NONCRITICAL _X                                    |
| 3.         | EVALUATION OF INSTALLATION:   |
|            | GOOD X FAIR POOR  |
| 4.         | COMMENTS: Pine Creek was surveyed this year. This structure was     |
|            | surveyed August 4th. No log weirs were observed.                    |
|            |   |
|            |   |
|            |   |
|            |   |

| REF. NO. 3-A |
|--------------|
|--------------|

| EVAL | UATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:                        |
|------|---|
| ١.   | CULVERT CONDITION:  |
|      | GOOD FAIR X POOR  |
| 2.   | CULVERT CAPACITY:   |
|      | GOOD FAIR X POOR  |
| 3.   | TYPE OF CULVERT FOUNDATION:   |
|      | METAL FOOTING CONCRETE FOOTING CLOSEDX                                    |
| 4.   | CONDITION OF FOUNDATION:  |
|      | GOOD X FAIR POOR POOR   |
| 5.   | OUTLET SCOUR:   |
|      | SEVERE X MODERATE NEGLIGIBLE  |
| 6.   | CULVERT STREAM SURFACE:   |
|      | METAL X CONCRETE NATURAL  |
| 7.   | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                          |
|      | COMPATIBLE X  |
| 8.   | COMMENTS: The metal invert and steep gradient create barrel velocities    |
|      | that are nearly double the velocities in the natural stream channel.      |
|      | Also, a 2 to 3 foot deep scour hole that may impede fish passage at lower |
|      | flows. However, the short pipe length and a natural beaver pond below     |
|      | the pipe may permit the passage of fish through the installation.         |
|      | In general, this is not a good installation for the passage of fish. If   |
|      | the pipe were replaced and/or lengthened, fish passage would be difficult |
|      | under the current circumstances. Also, there is no guarantee that the     |

beaver pond will remain in place.

REF. NO. 3-A



3Aa - Culvert Outlet



3Ab - Typical Stream Channel

| REF. | NO. | 7-A |  |
|------|-----|-----|--|
|      |     |     |  |

| DATE: <u>12</u> / | /8/87 DATA BY: Bill Howard, James Bryant                             |
|-------------------|--|
| STREAM: L         | Haight Creek ODF&W REP.: Jerry MacLeod                               |
| LOCATION:         | Upper Siuslaw River Tributary, Lane County; T19S, R7W, Section 34    |
| TYPE OF I         | NSTALLATION: Structural Plate Arch                                   |
| DIMENSIONS        | S: SPAN 18.2' RISE 8.9' DIAM.  |
|                   | LENGTH 69'   |
|                   | GRADIENT 0.0015 foot/foot  |
| SPECIAL FI        | EATURES: Open bottom arch  |
| EVALUATIO         | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.                | TYPE AND CONDITION OF SPECIES: Anadromous and resident salmonids.    |
|                   | Including chinook and coho salmon and cutthroat and steelhead trout. |
|                   | Would not affect condition of species.                               |
| 2.                | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|                   | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.                | EVALUATION OF INSTALLATION:  |
|                   | GOOD X FAIR POOR POOR  |
|                   |  |
| 4.                | COMMENTS: Access to stream good at most flows, except extreme low    |
| summ              | er time. Metal of culvert beginning to corrode near waterline, but   |
| conc              | rete sill shows no sign of wear. No buildup of gravel or other       |
| mate              | rial. Soft sandstone bedrock bottom. Bridge was offset from normal   |
| stre              | am channel by 15 feet on upstream end. Bridge should have been       |
| plac              | ed more directly in-line with stream flow. Some erosion noted at     |
| this              | point, probably due to creation of back eddy.                        |
|                   |  |

SHEET 2 OF 3

REF. NO. \_7-A

| EVALUATION | 0F | CULVERT | INSTALLATION | ΒY | WFLHD | PERSONNEL: |
|------------|----|---------|--------------|----|-------|------------|
|------------|----|---------|--------------|----|-------|------------|

| 1. | CULVERT CONDITION:  |
|----|---|
|    | GOOD FAIR X POOR  |
| 2. | CULVERT CAPACITY:   |
|    | GOOD X FAIR POOR  |
| 3. | TYPE OF CULVERT FOUNDATION:   |
|    | METAL FOOTING CONCRETE FOOTING X CLOSED                                 |
| 4. | CONDITION OF FOUNDATION:  |
|    | GOOD FAIR X POOR  |
| 5. | OUTLET SCOUR:   |
|    | SEVERE MODERATE NEGLIGIBLEX   |
| 6. | CULVERT STREAM SURFACE:   |
|    | METAL CONCRETE NATURAL _X   |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                        |
|    | COMPATIBLE X INCOMPATIBLE   |
| 8. | COMMENTS: This open bottom arch is a good installation overall. However |
|    | the concrete footings appear to be located on sandstone. Thus, scour a  |
|    | the foundations may be a problem.                                       |
|    |   |
|    |   |

REF. NO. 7-A



7Aa - Culvert Barrel



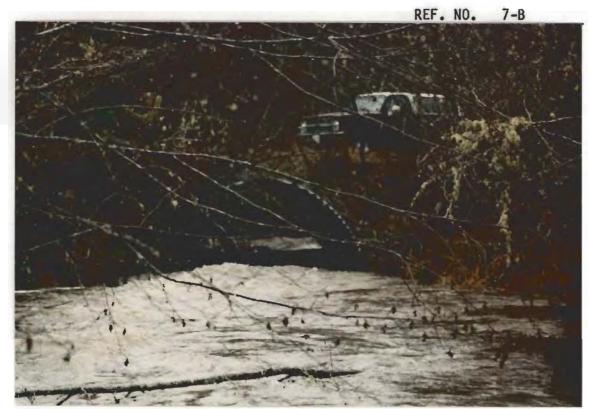
7Ab - Typical Stream Channel

| REF. | NO. | 7-B |  |
|------|-----|-----|--|
|      |     |     |  |

| DATE: 12/  | /8/87 DATA BY: Bill Howard, James Bryant                             |
|------------|--|
| STREAM: E  | Eames Creek ODF&W REP.: Jerry MacLeod                                |
|            | Wolf Creek Tributary, Lane County; T19S, R6W, Section 7              |
|            |  |
| TYPE OF IN | NSTALLATION: Structural Plate Arch                                   |
| DIMENSIONS | S: SPAN 13.8' RISE 6.9' DIAM.  |
|            | LENGTH 56'   |
|            | GRADIENT 0.002 foot/foot   |
| SPECIAL F  | EATURES: Open bottom arch  |
| EVALUATIO  | N OF PASSAGE FACILITIES BY ODF&W PERSONNEL:                          |
| 1.         | TYPE AND CONDITION OF SPECIES: Anadromous and resident salmonids.    |
|            | Including chinook and coho salmon and cutthroat and steelhead trout. |
|            | Would not affect condition of species.                               |
| 2.         | IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:                       |
|            | CRITICAL X MODERATE NONCRITICAL                                      |
| 3.         | EVALUATION OF INSTALLATION:  |
|            | GOOD X FAIR POOR   |
|            | ACMIEUTO A   |
| 4.         |  |
|            | flows. No build-up of gravel or other material. Soft sandstone       |
|            | bedrock bottom.  |
|            | Bridge not constructed directly in-line with stream, but off 20 to   |
|            | 30 degrees to left as you look downstream. Rip-rap material          |
|            | prevents any damage to stream banks.                                 |
|            |  |

# EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

| ١. | CULVERT CONDITION:   |
|----|--|
|    | GOOD FAIR X POOR   |
| 2. | CULVERT CAPACITY:  |
|    | GOOD FAIR X POOR   |
| 3. | TYPE OF CULVERT FOUNDATION:  |
|    | METAL FOOTING CONCRETE FOOTING X CLOSED                                  |
| 4. | CONDITION OF FOUNDATION:   |
|    | GOOD FAIR X POOR   |
| 5. | OUTLET SCOUR:  |
|    | SEVERE MODERATE NEGLIGIBLEX  |
| 6. | CULVERT STREAM SURFACE:  |
|    | METAL CONCRETE NATURALX  |
| 7. | CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:                         |
|    | COMPATIBLE X INCOMPATIBLE  |
| 8. | COMMENTS: This open bottom arch is a good installation overall. However, |
|    | the concrete footings appear to be located on sandstone. Thus, scour at  |
|    | the foundations may be a problem.  |
|    |  |
|    |  |



7Ba - Culvert Outlet



7Bb - Typical Stream Channel

APPENDIX C

STREAM HYDROLOGY

|       | LIST OF SYMBOLS AND DIMENSIONS                         |
|-------|--|
| Q2    | Two year flood, in cubic feet per second (cfs)         |
| Q5    | Five year flood, in cubic feet per second (cfs)        |
| Q10   | Ten year flood, in cubic feet per second (cfs)         |
| Q25   | Twenty-five year flood, in cubic feet per second (cfs) |
| Q50   | Fifty year flood, in cubic feet per second (cfs)       |
| Q1 00 | One hundred year flood, in cubic feet per second (cfs) |
| P     | Mean annual precipitation, in inches                   |
| F     | Percent of basin forest                                |
| I     | Precipitation intensity, in inches                     |
| ST    | Area of lakes and ponds, in percent                    |
| TI    | Mean basin January minimum temperature, in degrees     |
| L     | Length of channel, in miles                            |

#### SUMMARY OF HYDROLOGIC COMPUTATIONS

# EASTERN OREGON NORTHEAST REGION 2

| *****   | *****   | *****  | *******  | *****  | ******  | *****   | *****   | *****   | *****   | ******   | *****  |
|---------|---|--|--|--|---|---|---|---|---|--|--|
|         |   | Α  | Р  | F  | Q2  | Q5  | Q10   | Q25   | Q50   | Q100   |  |
| LAT.    | LONG.   | <u> 5Q. MI.</u>  | INCHES   | PERCENT  | <u>CFS</u>  | <u>CFS</u>  | <u>CFS</u>  | CFS   | <u>CFS</u>  | CFS  |  |
|         |   |  |  |  |   |   |   |   |   |  |  |
| 44-10.0 | 119-35.0  | 22.60  | 20.00  | 50.00  | 133   | 231   | 303   | 395   | 486   | 565  |  |
| 44-53.0 | 119-01.0  | 11.40  | 20.00  | 50.00  | 76  | 134   | 178   | 233   | 289   | 336  |  |
| 44-51.5 | 119-02.0  | 14.50  | 20.00  | 50.00  | 93  | 162   | 214   | 281   | 347   | 403  |  |
| 44-38.0 | 118-40.0  | 5.50   | 20.00  | 50.00  | 42  | 76  | 101   | 133   | 166   | 193  |  |
| 44-47.5 | 118-55.0  | 23.50  | 25.00  | 50.00  | 186   | 303   | 387   | 490   | 592   | 677  |  |
| 44-46.0 | 118-52.5  | 30.70  | 25.00  | 50.00  | 232   | 375   | 477   | 602   | 725   | 830  |  |
| 44-13.5 | 118-51.0  | 27.80  | 25.00  | 50.00  | 214   | 346   | 441   | 558   | 673   | 770  |  |
| 44-13.3 | 118-50.5  | 11.90  | 25.00  | 50.00  | 107   | 177   | 228   | 290   | 353   | 404  |  |
| 44-13.0 | 118-50.0  | 11.50  | 25.00  | 50.00  | 104   | 173   | 222   | 283   | 344   | 394  |  |
| 45-47.0 | 117-56.0  | 10.80  | 30.00  | 50.00  | 126   | 200   | 251   | 313   | 376   | 425  |  |
| 45-47.0 | 117-53.0  | 18,20  | 30.00  | 50.00  | 194   | 302   | 378   | 468   | 559   | 631  |  |
| 45-42.0 | 116-55.5  | 2.00   | 15.00  | 70.00  | 11  | 22  | 31  | 43  | 55  | 65   |  |
| 45-44.0 | 116-54.5  | 4.80   | 15.00  | 70.00  | 23  | 45  | 52  | 84  | . 107   | 126  |  |
| 45-33.0 | 116-50.5  | 48.20  | 15.00  | 70.00  | 153   | 278   | 373   | 497   | 619   | 729  |  |
| 45-40.0 | 116-57.0  | 25.50  | 15.00  | 70.00  | 91  | 168   | 227   | 304   | 381   | 449  |  |
| 45-42.5 | 117-09.5  | 55.80  | 12.50  | 70.00  | 135   | 256   | 351   | 478   | 603   | 719  |  |
| 45-11.0 | 116-52.5  | 18.80  | 25.00  | 70.00  | 142   | 230   | 292   | 368   | 444   | 504  |  |
| 45-46.5 | 116-55.5  | 6.10   | 15.00  | 70.00  | 28  | 54  | 74  | 101   | 129   | 151  |  |
| 45-46.0 | 116-59.5  | 10.70  | 15.00  | 70.00  | 45  | 85  | 115   | 156   | 197   | 232  |  |
| 45-45.0 | 117-01.0  | 5.30   | 15.00  | 70.00  | 25  | 49  | 67  | 91  | 116   | 136  |  |
| 45-42.5 | 117-09.5  | 25.50  | 12.50  | 70.00  | 71  | 138   | 191   | 261   | 333   | 397  |  |
|         | LAT.  44-10.0  44-53.0  44-51.5  44-38.0  44-47.5  44-46.0  44-13.5  44-13.3  44-13.0  45-47.0  45-47.0  45-42.0  45-42.0  45-42.0  45-46.0  45-46.5  45-46.0  45-46.5  45-46.0 | LAT. LONG.  44-10.0 119-35.0 44-53.0 119-01.0 44-51.5 119-02.0 44-38.0 118-40.0 44-47.5 118-55.0 44-46.0 118-52.5 44-13.5 118-51.0 44-13.3 118-50.5 44-13.0 118-50.0 45-47.0 117-56.0 45-47.0 117-55.5 45-44.0 116-55.5 45-40.0 116-57.0 45-42.5 117-09.5 45-46.5 116-55.5 45-46.0 116-59.5 45-45.0 117-01.0 | A LAT. LONG. SQ. MI.  44-10.0 119-35.0 22.60 44-53.0 119-01.0 11.40 44-51.5 119-02.0 14.50 44-38.0 118-40.0 5.50 44-47.5 118-55.0 23.50 44-46.0 118-52.5 30.70 44-13.5 118-51.0 27.80 44-13.3 118-50.5 11.90 44-13.0 118-50.0 11.50 45-47.0 117-56.0 10.80 45-47.0 117-55.0 18.20 45-42.0 116-55.5 2.00 45-44.0 116-54.5 4.80 45-33.0 116-50.5 48.20 45-40.0 116-57.0 25.50 45-42.5 117-09.5 55.80 45-11.0 116-52.5 18.80 45-46.0 116-59.5 10.70 45-45.0 117-01.0 5.30 | LAT.         LONG.         SQ. MI.         INCHES           44-10.0         119-35.0         22.60         20.00           44-53.0         119-01.0         11.40         20.00           44-51.5         119-02.0         14.50         20.00           44-38.0         118-40.0         5.50         20.00           44-38.0         118-55.0         23.50         25.00           44-47.5         118-55.0         23.50         25.00           44-46.0         118-52.5         30.70         25.00           44-13.5         118-51.0         27.80         25.00           44-13.3         118-50.5         11.90         25.00           44-13.0         118-50.0         11.50         25.00           45-47.0         117-56.0         10.80         30.00           45-47.0         117-53.0         18.20         30.00           45-42.0         116-55.5         2.00         15.00           45-43.0         116-50.5         48.20         15.00           45-40.0         116-57.0         25.50         15.00           45-42.5         117-09.5         55.80         12.50           45-46.5         116-52.5         18.80 | LAT.         LONG.         SQ. MI.         INCHES         PERCENT           44-10.0         119-35.0         22.60         20.00         50.00           44-53.0         119-01.0         11.40         20.00         50.00           44-51.5         119-02.0         14.50         20.00         50.00           44-38.0         118-40.0         5.50         20.00         50.00           44-47.5         118-55.0         23.50         25.00         50.00           44-46.0         118-55.0         27.80         25.00         50.00           44-13.5         118-51.0         27.80         25.00         50.00           44-13.3         118-50.5         11.90         25.00         50.00           44-13.0         118-50.0         11.50         25.00         50.00           45-47.0         117-56.0         10.80         30.00         50.00           45-47.0         117-53.0         18.20         30.00         50.00           45-42.0         116-55.5         2.00         15.00         70.00           45-44.0         116-54.5         4.80         15.00         70.00           45-42.5         117-09.5         55.80         12.50 </td <td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133           44-53.0         119-01.0         11.40         20.00         50.00         76           44-51.5         119-02.0         14.50         20.00         50.00         93           44-38.0         118-40.0         5.50         20.00         50.00         42           44-47.5         118-55.0         23.50         25.00         50.00         186           44-46.0         118-52.5         30.70         25.00         50.00         232           44-13.5         118-51.0         27.80         25.00         50.00         214           44-13.3         118-50.5         11.90         25.00         50.00         107           44-13.0         118-50.0         11.50         25.00         50.00         104           45-47.0         117-56.0         10.80         30.00         50.00         126           45-42.0         116-55.5         2.00         15.00         70.00         13           45-43.0         116-50.5         48.20         15.00         70.00</td> <td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231           44-53.0         119-01.0         11.40         20.00         50.00         76         134           44-51.5         119-02.0         14.50         20.00         50.00         93         162           44-38.0         118-40.0         5.50         20.00         50.00         42         76           44-47.5         118-55.0         23.50         25.00         50.00         186         303           44-46.0         118-55.5         30.70         25.00         50.00         232         375           44-13.5         118-51.0         27.80         25.00         50.00         214         346           44-13.3         118-50.5         11.90         25.00         50.00         107         177           44-13.0         118-50.0         11.50         25.00         50.00         104         173           45-47.0         117-56.0         10.80         30.00         50.00         194         302           45-42.0         116-54.5</td> <td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477           44-13.5         118-51.0         27.80         25.00         50.00         214         346         441           44-13.3         118-50.0         11.50         25.00         50.00         107         177         228           44-7.0         117-56.0         10.80         30.00         50.00         104         173         222           45-47.0<td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602           44-13.3         118-50.0         27.80         25.00         50.00         107         177         228         290           44-13.0         118-50.0         11.50         25.00         50.00         104         173         222         283           45-47.0         117-56.0</td><td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602         725           44-13.3         118-50.5         11.90         25.00         50.00         107         177         228         290         353           44-13.0         118-50.0         11.50         25.00         5</td><td>LAT.         LONG.         SQ. MI.         INCHES         F PERCENT         Q2 CFS         Q5 CFS         Q10 Q25 CFS         Q50 Q100 CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486         565           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289         336           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347         403           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166         193           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592         677           44-46.0         118-55.0         23.50         25.00         50.00         232         375         477         602         725         830           44-13.5         118-50.0         27.80         25.00         50.00         107         177         228         290</td></td> | LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133           44-53.0         119-01.0         11.40         20.00         50.00         76           44-51.5         119-02.0         14.50         20.00         50.00         93           44-38.0         118-40.0         5.50         20.00         50.00         42           44-47.5         118-55.0         23.50         25.00         50.00         186           44-46.0         118-52.5         30.70         25.00         50.00         232           44-13.5         118-51.0         27.80         25.00         50.00         214           44-13.3         118-50.5         11.90         25.00         50.00         107           44-13.0         118-50.0         11.50         25.00         50.00         104           45-47.0         117-56.0         10.80         30.00         50.00         126           45-42.0         116-55.5         2.00         15.00         70.00         13           45-43.0         116-50.5         48.20         15.00         70.00 | LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231           44-53.0         119-01.0         11.40         20.00         50.00         76         134           44-51.5         119-02.0         14.50         20.00         50.00         93         162           44-38.0         118-40.0         5.50         20.00         50.00         42         76           44-47.5         118-55.0         23.50         25.00         50.00         186         303           44-46.0         118-55.5         30.70         25.00         50.00         232         375           44-13.5         118-51.0         27.80         25.00         50.00         214         346           44-13.3         118-50.5         11.90         25.00         50.00         107         177           44-13.0         118-50.0         11.50         25.00         50.00         104         173           45-47.0         117-56.0         10.80         30.00         50.00         194         302           45-42.0         116-54.5 | LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477           44-13.5         118-51.0         27.80         25.00         50.00         214         346         441           44-13.3         118-50.0         11.50         25.00         50.00         107         177         228           44-7.0         117-56.0         10.80         30.00         50.00         104         173         222           45-47.0 <td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602           44-13.3         118-50.0         27.80         25.00         50.00         107         177         228         290           44-13.0         118-50.0         11.50         25.00         50.00         104         173         222         283           45-47.0         117-56.0</td> <td>LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602         725           44-13.3         118-50.5         11.90         25.00         50.00         107         177         228         290         353           44-13.0         118-50.0         11.50         25.00         5</td> <td>LAT.         LONG.         SQ. MI.         INCHES         F PERCENT         Q2 CFS         Q5 CFS         Q10 Q25 CFS         Q50 Q100 CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486         565           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289         336           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347         403           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166         193           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592         677           44-46.0         118-55.0         23.50         25.00         50.00         232         375         477         602         725         830           44-13.5         118-50.0         27.80         25.00         50.00         107         177         228         290</td> | LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602           44-13.3         118-50.0         27.80         25.00         50.00         107         177         228         290           44-13.0         118-50.0         11.50         25.00         50.00         104         173         222         283           45-47.0         117-56.0 | LAT.         LONG.         SQ. MI.         INCHES         PERCENT         CFS         CFS         CFS         CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592           44-46.0         118-52.5         30.70         25.00         50.00         232         375         477         602         725           44-13.3         118-50.5         11.90         25.00         50.00         107         177         228         290         353           44-13.0         118-50.0         11.50         25.00         5 | LAT.         LONG.         SQ. MI.         INCHES         F PERCENT         Q2 CFS         Q5 CFS         Q10 Q25 CFS         Q50 Q100 CFS           44-10.0         119-35.0         22.60         20.00         50.00         133         231         303         395         486         565           44-53.0         119-01.0         11.40         20.00         50.00         76         134         178         233         289         336           44-51.5         119-02.0         14.50         20.00         50.00         93         162         214         281         347         403           44-38.0         118-40.0         5.50         20.00         50.00         42         76         101         133         166         193           44-47.5         118-55.0         23.50         25.00         50.00         186         303         387         490         592         677           44-46.0         118-55.0         23.50         25.00         50.00         232         375         477         602         725         830           44-13.5         118-50.0         27.80         25.00         50.00         107         177         228         290 |

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### SUMMARY OF HYDROLOGIC COMPUTATIONS

| ************************************** |                               |          |         |        |            |             |            |             |            |            |             |      |
|--|-------------------------------|----------|---------|--------|------------|-------------|------------|-------------|------------|------------|-------------|------|
| NORTH CENTRAL REGION 3                 |                               |          |         |        |            |             |            |             |            |            |             |      |
| ************************************** |                               |          |         |        |            |             |            |             |            |            |             |      |
|  |                               |          | A       | P      | TI         | Q2          | Q5         | Q10         | Q25        | Q50        | Q100        |      |
| <u>LOCATION</u>                        | LAT.                          | LONG.    | SQ. MI. | INCHES | DEGREES    | CFS         | <u>CFS</u> | <u>CFS</u>  | CFS        | CFS        | CFS         |      |
| MARK                                   | 44-27.0                       | 120-27.5 | 29.10   | 25.00  | 16.00      | 116         | 241        | 330         | 481        | 595        | 75 <b>7</b> |      |
| MEACHAM                                | 44-30.5                       | 118-25.0 | 16.20   | 20.00  | 18.00      | 74          | 172        | 250         | 387        | 499        | 655         |      |
| MEACHAM                                | 44-30.6                       | 118-24.5 | 22,20   | 20.00  | 18.00      | 96          | 219        | 316         | 486        | 622        | 814         |      |
| MEACHAM                                | 44-30.6                       | 118-24.4 | 22.30   | 20.00  | 18.00      | 96          | 220        | 317         | 487        | 624        | 816         |      |
| MEACHAM                                | 44-30.6                       | 118-24.0 | 22.40   | 20.00  | 18.00      | 96          | 221        | 318         | 489        | 626        | 819         |      |
| SHEEP                                  | 44-30.6                       | 118-23.9 | 3.00    | 20.00  | 18.00      | 19          | 48         | 72          | 115        | 153        | 204         |      |
| POLALLIE                               | 45-25.0                       | 121-34.0 | 4.33    | 90.00  | 26.00      | 423         | 647        | 772         | 952        | 1088       | 1276        |      |
| ************************************** |                               |          |         |        |            |             |            |             |            |            |             |      |
| EASTERN CASCADES REGION 4              |                               |          |         |        |            |             |            |             |            |            |             |      |
| ********                               | *****                         | *****    |         | *****  |            |             |            |             |            |            | ********    | **** |
| LOCATION                               |                               |          | Р       | Ļ      | Q2         | Q5          | Q10        | <b>Q</b> 25 | Q50        | Q100       |             |      |
| LOCATION                               | LAT.                          | LONG.    | INCHES  | MILES  | <u>CFS</u> | <u>CF\$</u> | <u>CFS</u> | <u>CFS</u>  | <u>CFS</u> | <u>CFS</u> |             |      |
| BROWN                                  | 43-43.0                       | 121~48.0 | 25.00   | 13.00  | 98         | 180         | 249        | 333         | 412        | 500        |             |      |
| ******                                 |                               |          |         |        |            |             |            |             |            |            | *****       | **** |
|  |                               |          |         |        | WESTE      | RN OREGO    | N          |             |            |            |             |      |
|  | WESTERN OREGON COAST REGION 1 |          |         |        |            |             |            |             |            |            |             |      |
| ************************************** |                               |          |         |        |            |             |            |             |            |            |             |      |
|  |                               |          | Α       | I      | ST         | Q2          | Q5         | 010         | Q25        | Q50        | Q100        |      |
| LOCATION                               | LAT.                          | LONG.    | SQ. MI. | INCHES | PERCENT    | CFS         | CFS        | CFS         | CFS        | CFS        | CFS         |      |
|  |                               |          |         |        |            | _           | _          |             |            |            |             |      |
| HAIGHT                                 | 43-52.5                       | 123-30.0 | 4.00    | 3.50   | 0.00       | 190         | 269        | 318         | 382        | 438        | 481         |      |
| EAMES                                  | 43-57.5                       | 123-27.0 | 5.20    | 3.75   | 0.00       | 279         | 395        | 466         | 560        | 642        | 704         |      |

### SUMMARY OF HYDROLOGIC COMPUTATIONS

| ************************************** |
|--|
| WILLAMETTE REGION 2                    |
| ************************************** |

| LOCATION  | LAT.    | LONG.    | A<br>SQ. MI. | I<br>INCHES | Q2<br><u>CFS</u> | Q5<br><u>CFS</u> | Q10<br>CFS | Q25<br><u>CFS</u> | Q50<br><u>CFS</u> | Q100<br>CFS |
|-----------|---------|----------|--------------|-------------|------------------|------------------|------------|-------------------|-------------------|-------------|
| PINE      | 45-01.0 | 122-25.0 | 4.00         | 3,50        | 248              | 368              | 454        | 571               | 664               | 760         |
| LOWE      | 44-57.5 | 121-52.5 | 6.80         | 3.75        | 442              | 654              | 800        | 1001              | 1160              | 1322        |
| POOP      | 44-57.5 | 121-50.5 | 1.74         | 3.75        | 135              | 197              | 241        | 302               | 350               | 398         |
| MT. SCOTT | 45-26.0 | 122-32.5 | 2.65         | 2.70        | 111              | 177              | 216        | 279               | 329               | 383         |
| COOL      | 45-17.5 | 121-53.0 | 1.65         | 4.00        | 144              | 208              | 253        | 315               | 363               | 412         |
| LOST      | 45-22.5 | 121-50.0 | 3.20         | 4.00        | 256              | 372              | 453        | 563               | 650               | 738         |
| NEWELL    | 45-21.0 | 122-35.0 | 2.10         | 2.75        | 94               | 144              | 181        | 233               | 275               | 319         |

# APPENDIX D

STREAM CHANNEL HYDRAULICS

## NATURAL STREAM CHANNEL HYDRAULICS

|                | (1)      | (Q)     | (B)    | (ZF)     | (ZB)     | (N)       | (S)    | (D)         | (V)        | (TD)   | (RS)          |
|----------------|----------|---------|--------|----------|----------|-----------|--------|-------------|------------|--------|---------------|
|                | RETURN   | RUNOFF  | BOTTOM | FORE     | BACK     | MANNINGS  | DITCH  | FLOW        |            | SHEAR  | RIPRAP        |
|                | INTERVAL | Q       | HTDIW  | SLOPE    | SLOPE    | ROUGHNESS | SLOPE  | DEPTH       | VELOCITY   | STRESS | SIZE          |
| STREAM NAME    | YEARS_   | CFS     | FEET   | HOR UNIT | HOR UNIT | <u> </u>  | FT/FT  | <u>FEET</u> | <u>FPS</u> | LB/FT2 | <u>D50,FT</u> |
| WT 600TT       | •        | 110.00  | 10.00  | 2.50     | 2.00     | 0.045     | 0.0175 | 1.70        | 4.68       | 1.86   | 0.37          |
| MT SCOTT       | 2        | 110.00  | 10.00  | 2.50     | 2.00     | 0.045     | 0.0175 | 3.00        | 6.57       | 3.28   | 0.66          |
| MT SCOTT       | 50       | 329.99  | 10.00  | 2.50     | 2.00     | 0.045     |        |             |            |        | 0.20          |
| NEWELL         | 2        | 96.73   | 13.00  | 3.50     | 1.50     | 0.045     | 0.0100 | 1.60        | 3.56       | 1.00   |               |
| NEWELL         | 50       | 278.10  | 13.00  | 3.50     | 1.50     | 0.045     | 0.0100 | 2.80        | 4.97       | 1.75   | 0.35          |
| C00L           | 2        | 145.63  | 6.00   | 4.00     | 2.00     | 0.045     | 0.0100 | 2.50        | 4.31       | 1.56   | 0.37          |
| COOL           | 50       | 364.07  | 6.00   | 4.00     | 2.00     | 0.045     | 0.0100 | 3.80        | 5.51       | 2.37   | 0.47          |
| LOST           | 2        | 258.04  | 18.00  | 1.00     | 4.00     | 0.045     | 0.0140 | 2.10        | 5.28       | 1.83   | 0.37          |
| LOST           | 50       | 651.24  | 18.00  | 1.00     | 4.00     | 0.045     | 0.0140 | 3.50        | 6.96       | 3.06   | 0.61          |
| POLLALIE       | 2        | 424.59  |        | 4.00     | 4.50     | 0.045     | 0.0430 | 3.30        | 9.17       | 8.85   | 1.77          |
| · POLLALIE     | 50       | 1090.91 |        | 4.00     | 4.50     | 0.045     | 0.0430 | 4.70        | 11.62      | 12.61  | 2.52          |
| MOTTET         | 2        | 125.52  | 3.00   | 8.00     | 3.00     | 0.045     | 0.0500 | 1.60        | 6.65       | 4.99   | 1.00          |
| MOTTET         | 50       | 375.00  | 3.00   | 8.00     | 3,00     | 0.045     | 0.0500 | 2.50        | 8.96       | 7.80   | 1,56          |
| LOOKING GLASS  | 2        | 193.70  |        | 6.67     | 46.67    | 0.045     | 0.0224 | 1.40        | 3.71       | 1.96   | 0.39          |
| LOOKING GLASS  | 50       | 557.85  |        | 6.67     | 46.67    | 0.045     | 0.0224 | 2.10        | 4.74       | 2.94   | 0.59          |
| TAMARACK GULCH | 2        | 11.00   |        | 5.00     | 7.00     | 0.040     | 0.0326 | 0.80        | 2.87       | 1.63   | 0.33          |
| TAMARACK GULCH | 50       | 55.01   |        | 5.00     | 7.00     | 0.040     | 0.0326 | 1.40        | 4.68       | 2.85   | 0.57          |
| S.F. CHESNIMUS | 2        | 23.24   | 7.00   | 9.00     | 3.50     | 0.040     | 0.0300 | 0.60        | 3.60       | 1.12   | 0.22          |
| S.F. CHESNIMUS | 50       | 103.82  | 7.00   | 9.00     | 3,50     | 0.040     | 0.0300 | 1.30        | 5.28       | 2,43   | 0.49          |
| DEVILS RUN     | 2        | 27.89   | 5.00   | 5.00     | 5.00     | 0.040     | 0.0160 | 0.90        | 3.26       | 0.90   | 0.18          |
| DEVILS RUN     | 50       | 128.62  | 5.00   | 5.00     | 5.00     | 0.040     | 0.0160 | 1.90        | 4.67       | 1.90   | 0.38          |
| BILLY CREEK    | 2        | 44.94   | 6.00   | 1.00     | 1.50     | 0.040     | 0.0200 | 1.30        | 4.53       | 1.62   | 0.32          |
| BILLY CREEK    | 50       | 125.52  | 6.00   | 1.00     | 1.50     | 0.040     | 0.0200 | 2.20        | 6.52       | 2.75   | 0.55          |
| CAMP CREEK     | 2        | 153.41  | 10.00  | 3.50     | 1.75     | 0.040     | 0.0267 | 1.60        | 6.75       | 2.67   | 0.53          |
| CAMP CREEK     | 50       | 619.83  | 10.00  | 3.50     | 1.75     | 0.040     | 0.0267 | 3.30        | ` 10.06    | 5.50   | 1.10          |
| DOE CREEK      | 2        | 24.79   | 8.00   | 2.00     | 1.00     | 0.040     | 0.0250 | 0.70        | 3.91       | 1.09   | 0.22          |
|                | 50       | 116.22  | 8.00   | 2.00     | 1.00     | 0.040     | 0.0250 | 1.70        | 6.48       | 2.65   | 0.53          |
| DOE CREEK      | 50       | 110.22  | 0.00   | 2.00     | 1.00     | 0.040     | 0.0230 | 1.70        | 0.40       | 2.00   | 0.00          |

5

## NATURAL STREAM CHANNEL HYDRAULICS

|                    | (T)      | (Q)    | (B)    | (ZF)     | (ZB)     | (N)       | (S)          | (D)   | (V)      | (TD)<br>SHEAR | (RS)<br>RIPRAP |
|--------------------|----------|--------|--------|----------|----------|-----------|--------------|-------|----------|---------------|----------------|
|                    | RETURN   | RUNOFF | BOTTOM | FORE     | BACK     | MANNINGS  | DITCH        | FLOW  | VELOCITY | STRESS        | SIZE           |
|                    | INTERVAL | Q      | WIDTH  | SLOPE    | SLOPE    | ROUGHNESS | SLOPE        | DEPTH |          |               |                |
| STREAM NAME        | YEARS    | CFS    | FEET   | HOR UNIT | HOR UNIT | N         | <u>FT/FT</u> | FEET  | FPS      | LB/FT2        | <u>D50,FT</u>  |
| GUMBOOT CREEK      | 2        | 141.79 | 5.00   | 15.00    | 7.00     | 0.045     | 0.0230       | 1.50  | 4.40     | 2.15          | 0.43           |
| GUMBOOT CREEK      | 50       | 441.63 | 5.00   | 15,00    | 7.00     | 0.045     | 0.0230       | 2.40  | 5.86     | 3.44          | 0.69           |
| ELK CREEK          | 2        | 71.28  | 15.00  | 0.75     | 10.00    | 0.045     | 0.0190       | 1.00  | 3.50     | 1.19          | 0.24           |
| ELK CREEK          | 50       | 333.16 | 15.00  | 0.75     | 10.00    | 0.045     | 0.0190       | 2.20  | 5.65     | 2.61          | 0.52           |
| CHESNIMUS CREEK    | 2        | 91.43  | 8.00   | 5.00     | 7.50     | 0.040     | 0.0100       | 1.50  | 3.57     | 0.94          | 0.19           |
| CHESNIMUS CREEK    | 50       | 381.20 | 8.00   | 5.00     | 7.50     | 0.040     | 0.0100       | 2.90  | 5.03     | 1.81          | 0.36           |
| CROW CREEK         | 2        | 134.81 |        | 2.50     | 3.50     | 0.040     | 0.0130       | 3.00  | 4.99     | 2.43          | 0.49           |
| CROW CREEK         | 50       | 602.79 |        | 2.50     | 3.50     | 0.040     | 0.0130       | 5.20  | 7.43     | 4.22          | 0.84           |
| MEACHAM NO. 1 CRK  | 2        | 74.38  | 10.00  | 1.50     | 1.50     | 0.045     | 0.0100       | 1.60  | 3.75     | 1.00          | 0.20           |
| MEACHAM NO. I CRK  | 50       | 500.52 | 10.00  | 1,50     | 1.50     | 0.045     | 0.0100       | 4.50  | 6.64     | 2.81          | 0.56           |
| MEACHAM NO. 6 CRK  | 2        | 94.52  | 9.00   | 3.25     | 2.50     | 0.045     | 0.0150       | 1.60  | 4.34     | 1.50          | 0.30           |
| MEACHAM NO. 6 CRK  | 50       | 624.48 | 9.00   | 3.25     | 2.50     | 0.045     | 0.0150       | 4.10  | 7.33     | 3.84          | 0.77           |
| MEACHAM NO. 7 CRK  | 2        | 94.52  | 10.00  | 2.50     | 2.00     | 0.045     | 0.0240       | 1.40  | 5.13     | 2.10          | 0.42           |
| MEACHAM NO. 7 CRK  | 50       | 624.48 | 10.00  | 2.50     | 2.00     | 0.045     | 0.0240       | 3.80  | 8.86     | 5.69          | 1.14           |
| MEACHAM NO. 9 CRK  | 2        | 94.52  | 10.00  | 2.50     | 1.50     | 0.045     | 0.0180       | 1.50  | 4.85     | 1.68          | 0.34           |
| MEACHAM NO. 9 CRK  | 50       | 624.48 | 10.00  | 2.50     | 1.50     | 0.045     | 0.0180       | 4.10  | 8.37     | 4.61          | 0.92           |
| SHEEP CREEK        | 2        | 20.14  | 6.00   | 0.33     | 0.67     | 0.050     | 0.0600       | 0.70  | 4.53     | 2.62          | 0.52           |
| SHEEP CREEK        | 50       | 150.31 | 6.00   | 0.33     | 0.67     | 0.050     | 0.0600       | 2.30  | 9.14     | 8.61          | 1.72           |
| CANYON CREEK NO. 1 | 2        | 215.39 | 7.00   | 2.00     | 1.50     | 0.045     | 0.0210       | 2.70  | 6.80     | 3.54          | 0.71           |
| CANYON CREEK NO. 1 | 50       | 674.85 | 7.00   | 2.00     | 1.50     | 0.045     | 0.0210       | 4.80  | 9.13     | 6.29          | 1.26           |
| MF CANYON CREEK    | 2        | 110.02 | 10.00  | 5.50     | 5.50     | 0.045     | 0.0200       | 1.40  | 4.44     | 1.75          | 0.35           |
| MF CANYON CREEK    | 50       | 350.21 | 10.00  | 5.50     | 5.50     | 0.045     | 0.0200       | 2.50  | 5.90     | 3.12          | 0.62           |
| CANYON CREEK NO. 3 | 2        | 105.37 | 6.00   | 1.75     | 1.50     | 0.040     | 0.0180       | 2.00  | 5.70     | 2.25          | 0.45           |
| CANYON CREEK NO. 3 | 50       | 344.78 | 6.00   | 1.75     | 1.50     | 0.040     | 0.0180       | 3.60  | 8.08     | 4.04          | 0.81           |
| RUBY CREEK         | 2        | 40.29  | 7.00   | 2.25     | 1.50     | 0.040     | 0.0260       | 1.00  | 4.54     | 1.62          | 0.32           |
| RUBY CREEK         | 50       | 165.03 | 7.00   | 2.25     | 1.50     | 0.040     | 0.0260       | 2.10  | 7.19     | 3.41          | 0.68           |

#### NATURAL STREAM CHANNEL HYDRAULICS

|                   | (T)                | (Q)         | (B)             | (ZF)          | (ZB)          | (N)                   | (S)            | (D)<br>Flow | (V)      | (TD)<br>SHEAR | (RS)<br>RIPRAP |
|-------------------|--------------------|-------------|-----------------|---------------|---------------|-----------------------|----------------|-------------|----------|---------------|----------------|
|                   | RETURN<br>INTERVAL | RUNOFF<br>Q | BOTTOM<br>Width | FORE<br>SLOPE | BACK<br>SLOPE | MANNINGS<br>ROUGHNESS | DITCH<br>SLOPE | HT93G       | VELOCITY | STRESS        | SIZE           |
| CTDEAM NAME       |                    |             |                 |               |               |                       |                | FEET        | FPS      | LB/FT2        | D50,FT         |
| STREAM NAME       | YEARS              | CFS         | FEET            | HOR UNIT      | HOR UNIT      | <u> </u>              | FT/FT          | FEET        | 113      | <u> </u>      | 550,11         |
| BIG CREEK         | 2                  | 230.11      | 13.00           | 2.00          | 0.75          | 0.040                 | 0.0330         | 1.80        | 8.26     | 3.71          | 0.74           |
| BIG CREEK         | 50                 | 725.21      | 13.00           | 2.00          | 0.75          | 0.040                 | 0.0330         | 3.40        | 12.07    | 7.00          | 1.40           |
| INDIAN CREEK      | 2                  | 185.18      | 9.00            | 4.50          | 3.00          | 0.040                 | 0.0400         | 1.60        | 7.72     | 3,99          | 0.80           |
| INDIAN CREEK      | 50                 | 590.39      | 9.00            | 4.50          | 3.00          | 0.040                 | 0.0400         | 2.80        | 10.81    | 6.99          | 1.40           |
| GRANITE CRK NO. 1 | 2                  | 75.15       | 7.00            | 5.00          | 5.00          | 0.040                 | 0.0230         | 1.20        | 4.82     | 1.72          | 0.34           |
| GRANITE CRK NO. 1 | 50                 | 289.77      | 7.00            | 5.00          | 5.00          | 0.040                 | 0.0230         | 2.30        | 6.81     | 3.30          | 0.66           |
| GRANITE CRK NO. 2 | 2                  | 75.15       | 8.00            | 4.00          | 8.00          | 0.045                 | 0.0250         | 1.20        | 4.12     | 1.87          | 0.37           |
| GRANITE CRK NO. 2 | 50                 | 289.77      | 8.00            | 4.00          | 8.00          | 0.045                 | 0.0250         | 2.20        | 6.27     | 3.43          | 0.69           |
| GRANITE CRK NO. 3 | 2                  | 95.30       | 4.00            | 1.50          | 1.00          | 0.045                 | 0.0270         | 2.20        | 6.42     | 3.71          | 0.74           |
| GRANITE CRK NO. 3 | 50                 | 350.21      | 4.00            | 1.50          | 1.00          | 0.045                 | 0.0270         | 4.20        | 9.01     | 7.08          | 1.42           |
| SUNFLOWER CREEK   | 2                  | 134.81      | 18.00           | 7.50          | 5.00          | 0.045                 | 0.0340         | 1.10        | 4.93     | 2.33          | 0.47           |
| SUNFLOWER CREEK   | 50                 | 485.02      | 18.00           | 7.50          | 5.00          | 0.045                 | 0.0340         | 2.10        | 7.42     | 4.46          | 0.89           |
| MARK'S CREEK      | 2                  | 114.67      | 10.00           | 2.25          | 8.00          | 0.040                 | 0.0080         | 1.70        | 3.60     | 0.85          | 0.17           |
| MARK'S CREEK      | 50                 | 599.69      | 10.00           | 2.25          | 8.00          | 0.040                 | 0.0080         | 3.70        | 5.60     | 1.85          | 0.37           |
| BROWN'S CREEK     | 2                  | 99.95       | 11.00           | 4.50          | 2.50          | 0.040                 | 0.0060         | 1.80        | 3.21     | 0.67          | 0.13           |
| BROWN'S CREEK     | 50                 | 399.79      | 11.00           | 4.50          | 2.50          | 0.040                 | 0.0060         | 3,60        | 4.71     | 1.35          | 0.27           |
| LOWE              | 2                  | 440.08      | 7.00            | 2.50          | 6.50          | 0.045                 | 0.0500         | 2.50        | 9.65     | 7.80          | 1.56           |
| LOWE              | 50                 | 1160.64     | 7.00            | 2.50          | 6.50          | 0.045                 | 0.0500         | 3.90        | 12.12    | 12.17         | 2.43           |
| POOP              | 2                  | 10.85       | 8.00            | 4.75          | 2.00          | 0.045                 | 0.0590         | 0.40        | 2.90     | 1.47          | 0.29           |
| POOP              | 50                 | 35.02       | 8.00            | 4.75          | 2.00          | 0.045                 | 0.0590         | 0.70        | 4.83     | 2.58          | 0.52           |
| PINE CREEK        | 2                  | 250.26      | 10.00           | 4.50          | 5.00          | 0.045                 | 0.0500         | 1.70        | 8.14     | 5.30          | 1.06           |
| PINE CREEK        | 50                 | 664.77      | 10.00           | 4.50          | 5.00          | 0.045                 | 0.0500         | 2.80        | 10.19    | 8.74          | 1.75           |
| HAIGHT CREEK      | 2                  | 190.44      | 17.00           | 11.25         | 0.75          | 0.040                 | 0,0050         | 2.10        | 3.06     | 0.66          | 0.73           |
| HAIGHT CREEK      | 50                 | 440.08      | 17.00           | 11.25         | 0.75          | 0.040                 | 0.0050         | 3.10        | 3.99     | 0.97          | 0.19           |
| EAMES CREEK       | 2                  | 280.48      | 14.00           | 3.00          | 1.75          | 0.040                 | 0.0040         | 3.30        | 3.89     | 0.82          | 0.16           |
| EAMES CREEK       | 50                 | 639.98      | 14.00           | 3.00          | 1.75          | 0.040                 | 0.0040         | 5.00        | 4.95     | 1.25          | 0.25           |

## APPENDIX E

CULVERT DESIGN SHEETS

## LIST OF SYMBOLS AND DIMENSIONS

| Q2  | Two year flood, in cubic feet per second (cfs)  |
|-----|---|
| Q50 | Fifty year flood, in cubic feet per second (cfs)  |
| Vb  | Culvert barrel velocity, in feet per second (fps)   |
| HW  | Headwater at culvert inlet, in feet (ft)  |
| R   | Rise of culvert, in feet (ft)   |
| Nb  | Manning's roughness value for the culvert barrel  |
| S   | Stream channel slope, in feet per foot (ft/ft)  |
| D50 | Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft) |
| D   | Pipe diameter or rise, in feet (ft)   |
| Ke  | Culvert inlet loss coefficient  |
| Н   | Energy head for culvert flowing full, in feet (ft)  |
| dc  | Critical depth, in feet (ft)  |
| TW  | Culvert tailwater, in feet (ft)   |
| ho  | Height of hydraulic grade line above outlet invert, in feet (ft)  |
| L   | Culvert barrel length, in feet (ft)   |
| So  | Culvert barrel slope, in feet (ft)  |

S. .

| fm sn -   b a<br> Rec 4 -   E |   |            |              |                  | С            | ะบ             | LV   | EF      | ?T             | DE              | SIC      | ξŅ     | S           | эн   | EET            | <b>-</b>     |                |                  |              |        |              | FEDERA             | ARTMENT OF BRANSPORTATION L HIGHWAY AGUNDSTRATION:<br>TEN VANCOUVER, WASHINGTON |
|-------------------------------|---|------------|--------------|------------------|--------------|----------------|--|---------|----------------|-----------------|----------|--------|-------------|------|----------------|--------------|----------------|------------------|--------------|--------|--------------|--------------------|---|
|                               |   |            |              |                  |              |                |  |         |                | 1-A             |          |        | ,           |      |                |              |                |                  |              |        |              | -                  | 1-A   |
| 101                           | C   |            | ज्ञात ।<br>ज | 1141             |              |                |  |         |                | 2.65            |          |        |             | •    | et tav         |              |                |                  |              |        |              |                    | HOLTATS   |
| Mt.                           | Scott   | ure        | <u> </u>     | n r m(           |              |                |  |         |                |                 | <u> </u> | -      | 16 WAL      | +461 | 1              | MIKIMU       | <u> </u>       |                  |              |        | •            |                    |   |
| USGS                          | Quad  | - "(       | alads        |                  | , On         | egon'          | 1  |         |                | :               | :        | ,      |             | - 1  | İ              |              |                |                  |              | •      |              |                    |   |
|                               |   |            |              |                  | ·            |                |  | •       |                | 25              | ~        | ······ |             | _    | ANTO.          |              |                |                  |              |        |              | /                  | <b>\</b>  |
|                               |   | 106411     | <b>14</b>    |                  |              |                | 3  | C1 10 4 |                | 7971115         | 2E       |        | M ( M I M A |      |                |              |                |                  |              |        |              |                    |   |
| •                             |   |            |              |                  |              |                |  |         |                |                 |          |        |             |      |                |              | /-             |                  |              |        |              | <u> </u>           |   |
| <del></del>                   |   |            | 111-1-       |                  |              |                |  | •       |                | 11/3/           |          |        |             | _    | 1              |              | ./ <u>.</u> .  |                  |              | ~~     | <b></b>      |                    |   |
| ·                             |   | rowni      | ing          |                  |              |                |  |         |                | 1 1/ 3/         |          |        |             |      | arx. 209       | .85 /        | j.<br>Grad     | 4-501_           | :0171        | 1/1 1. | 181.         | 5'                 |   |
| 0.0                           | 1   | 10 ct      |              |                  |              | ,              | w <sub>2</sub> -                                 |         |                | 1.7             |          |        |             | - 1  |                | •            |                |                  |              |        |              |                    | <u>niv 206, 75</u>  |
| °°2 —                         | , .   |            | • • • •      |                  |              |                | . 5 -  |         | <del></del>    | <u>.</u>        |          |        | -           | -1   | SCÁYSKI:       |              |                |                  |              |        | pprox        | mate:              | y 25' wide x 25'  |
| Q+#4                          | 3:  | 30 ç1      | fs .         |                  | •            | ·              | [₩·₩ _   |         |                | 3,0'            |          |        |             | -1   |                | long         | <u>x 2-</u>    | 1/2              | <u>deep.</u> |        |              |                    |   |
|                               |   |            | VERT         | DES              | CRIP         | TION           |  |         |                |                 | -1-      |        | н           | EADW | TER            | COM          | PUTAT          | ION              |              |        | ·            |                    |   |
|                               | 고유  | 받          | ٦            | दि               | 1            |                | ₫  | SIZE    | <b> </b>       | EKLET           | CONTROL  |        | ,           | ,    | TOUTLET        | CONTRO       | L HW           | HIN              | ·LSo         | т      | <del> </del> | <sub>1</sub>       | 1   |
| SIZE                          | CRETE<br>VC-EN  | CCT        | MITERED      | PLATE<br>PATE    | ĮŽ.          | MITERED        | SECTION  | D       | Q              |                 |          |        |             |      |                |              |                |                  |              | mitt   | Ę            | ,-È                | COMMENTS  |
| INCHES                        | 2000<br>2000<br>2000<br>2000<br>2000<br>2000<br>2000<br>200 | PROJECTING | 효            | <b>155</b>       | VERTICAL     | ž              | ě.   | rect    |                | D<br>HA         | HW       | κ.     | н           | ಕ್ಕ  | dc 10          | TW           | h <sub>o</sub> | L\$ <sub>0</sub> | -HW          | HW.    | OHT MOLLING  | OUTLET<br>VELOCITY | Connection  |
| Ka Cortikisal-                | 0 2   | 0.9        | 0.7          | 0.7              |              | 0.7            | 0.5  | 0       | ٠.             |                 |          |        |             |      |                |              |                |                  |              | ļ      | ě            | ۵Ä                 |   |
|                               | 1   | <u> </u>   |              | -                |              |                |  |         |                |                 |          |        | <b> </b>    |      | <del> </del>   |              | 1              | <u> </u>         |              |        |              | 1                  |   |
| Concret                       | e Bo  | k Cul      | vert         |                  | <u> </u>     | <u> </u>       |  |         |                |                 |          |        |             |      |                |              | <u> </u>       |                  |              |        |              |                    |   |
| 101.00                        | ا۔۔۔ا   |            | ر<br>ا       | , <sub>D</sub> . |              | J., 7          | J. 011   |         | - 661          | - <b>f</b> or 1 | 2 +60 0  | Lan.   |             |      |                | İ            |                |                  |              | 1      |              |                    |   |
| 100.                          | (spa  | 1) X       | 8 -0         | K15              | e w          | ועו ו          | <u>  -0 .</u>                                    | 1191    | patrie         | 5 10r i/        | 2 the s  | pan    | ļ           |      | ļ              | ļ <u> </u>   | <u> </u>       | <b> </b>         |              |        | ļ <u>.</u>   |                    | · · · · · · · · · · · · · · · · · · ·   |
|                               |   | -          |              |                  | İ            |                | 1  |         |                | 0.00            | 2.5      | ١, ,   | , ,         | , ,  | ١.,            | , ,          |                | ١,,              | , ,          |        | ا م د        | ,,                 | Dannal Valoaited  |
| Wing_W                        | lls.  | at 35      | o an         | ple_             | <del> </del> | <del> </del> — | <del> </del>                                     | -       | 110            | 0.33            | 2.6      | 0.4    | 0.1         | 1.5  | 4.8            | 1.7          | 4.8            | 3,1              | 1.8          | 0.2    | 2.6          | 1 1 1              | Barrel Velocity*  |
| <u>Wing Wa</u>                | 115   | at 35      | o an         | nle              |              |                |  | 7       | 330            | 0.7             | 5.6      | 0.4    | 0.5         | 3,3  | 5.7            | 3.0          | 5.7            | 3.1              | 3.1          | 0.4    | 5.6          | ∙15                | Barrel Velocity*  |
|                               |   |            |              |                  |              |                |  |         |                |                 |          |        |             |      |                |              |                |                  |              |        | ]            |                    |   |
|                               |   |            |              |                  |              |                | <del>                                     </del> |         | <del> </del> - |                 |          | 1      |             |      | <del> </del> - | <del> </del> |                | <del></del>      | <u> </u>     |        |              | <u> </u>           | <del> </del>  |
|                               | l   |            |              |                  |              |                | l  |         |                |                 |          |        |             |      |                |              |                |                  |              |        | <u> </u>     |                    | ·   |

SUMMARY AND RECOMMENDATIONS

\*Average velocity in unbaffled culvert span.

Due to high outlet velocities and high scour potential, the culvert outlet appears to be a potential barrier to fish passage through the culvert.

O est corrent plantife ton bome butt . .

Cini (ilini fittet

| fn. 6-111       |                      |          |          | · ·                              | C        | ะบ             | LV           | EF   | ?T           | DE       | SIC           | Ņ        | 9           | Н      | E.E.7          | Γ          |                |                       |                    |               |                    | FFOFMAI     | . HATMENT OF TRANSPORTATION, HIGHWAY ADMINISTRATION, TEM VAHCOUVER, WASHINGTON |
|-----------------|----------------------|----------|----------|----------------------------------|----------|----------------|--------------|--|--------------|----------|---------------|----------|-------------|--------|----------------|------------|----------------|-----------------------|--------------------|---------------|--------------------|-------------|--|
|                 |                      |          |          | hiling -                         |          | -              |              | <u>.                                    </u> |              | 1-8      | LA ,          |          | <u> </u>    |        |                |            |                |                       |                    |               |                    | _           | 1-B  |
| Newe            | 11 Cr                |          |          |                                  |          |                |              |  |              | 2.10     |               |          | 14WAE       | bu, £s | 12             | MIK (MU    | 4              |                       |                    | •             |                    | \           |  |
| USGS            | Ouad                 |          |          | an Ci                            | tv. (    | Oneac          | on"          |  |              |          |               |          |             |        |                |            |                |                       | /                  |               |                    |             |  |
|                 | 9444                 | -        | 51,034   | 31 24                            | <u> </u> |                |              | /2 <b>3</b>                                  |              |          | <del></del>   |          |             | -      | AKIT .         |            |                |                       |                    |               |                    |             |  |
|                 |                      | LOCATO   | 64       |                                  |          |                |              | /33  |              | 25       | 2E            | <u>.</u> | MC EI ØI AI | -1     |                |            | /              |                       |                    |               |                    | · ·         |  |
|                 |                      |          | lide(A   |                                  |          |                |              |  |              |          | , <del></del> |          |             |        |                | •          |                |                       |                    |               | <del></del> _      |             |  |
|                 | В                    | rown     |          |                                  |          |                |              |  |              | 11/3/    | /88           |          |             |        | .1             |            | / <u>·</u>     | <del>- : -</del>      | . 617              | <del>7</del>  | ~~~<br><del></del> | <del></del> |  |
|                 |                      | C=       | IC-EB    | 61                               |          |                | •            |  |              | 3.66     |               |          |             | _      | ef t.A         | , <i>'</i> |                |                       | .01                |               | <u> 439</u>        |             | ner.   |
| ۰۰.5 —          | <del>, 9</del>       | 5 çf     | <u>s</u> |                                  |          | — <sup>1</sup> | **2 -        | <del></del>                                  |              | 1.6      |               |          |             | -1     | REHARKSL       | Grav       | el_a           | and_ba                | ulder              | z plac        | ed in              | side t      | he culvert barrel.   |
| Q+++            | 2                    | 75 c     | fs       |                                  |          | 1              | A.M _        |  |              | 2.8'     |               |          |             | _[     |                | <u> </u>   |                |                       |                    |               |                    |             | · <u> </u>   |
|                 |                      | CUL      |          | DES                              |          |                |              | [  |              |          |               |          | К           | EADW   |                |            | UTAT           |                       |                    |               | ,                  |             |  |
|                 | 눈문물                  |          | <u> </u> | ij                               | بد ا     | _              | ě            | SIZE   |              | IKLET    | CONTROL       |          |             |        | OUTLET         | CONTRO     | L HW           | • # 1 1/ <sub>0</sub> | -L5 <sub>0</sub> _ | 1             | <u> 2</u>          |             |  |
| SIZE<br>INCHES  | CONCRET<br>BROOVE-EN | PROJECTM | MITERED  | STRUCTURAL<br>PLATE<br>(witches) | VERTICAL | KITERED        | END. SECTION | PEET   | a            | ο<br>HÃ  | нw            | ו        | н           | đc     | <u>dc+D</u> 2⋅ | tw         | h <sub>o</sub> | LS <sub>o</sub> .     | нж                 | HW.           | CONTROLLING        | OUTLET      | COMMENTS   |
| Ke Caelijeiant- | 0.2                  | 0,9      | 1.0      | 0.7                              | 0.5      | 0.7            | 0.5          | 0  | <u> </u>     |          |               |          |             |        | ļ              |            | •              | ļ. <u></u>            | ļ                  | ļ <u>.</u>    | 8                  | ->          |  |
| 14' d           | amet                 | er p     | pe s     | et a                             | pro      | imat           | ely 3        | bei  | ow the       | natura   | stream        | bed.     |             |        |                | 1          |                |                       |                    | 1             |                    |             |  |
| Use e           | uiva                 | lent     | 15'-     | 7" x                             | 10'      | 6" F           | ipe-A        | rch  |              |          |               |          |             |        |                |            |                |                       |                    |               |                    |             |  |
|                 | <br>                 |          |          |                                  |          |                | x            | 10.5   | 95           | 0.2      | 2.1           | 0.5      | 0.10        | 1.0    | 5.7            | 1.6        | 5.7            | 4.4                   | 1.4                | 0.1           | 2.1                | 4.0         | Barrel Velocity  |
|                 |                      |          |          |                                  |          |                | Х            | 10.5   | 275          | 0.4      | 4.2           | 0.5      | .50         | 1.6    | 6,0            | 2.8        | 6.0            | 4.4                   | 2.1                | 0.2           | 4.2                | .6.0        | Barrel Velocity  |
|                 |                      |          |          |                                  |          |                |              |  |              |          |               |          |             |        |                |            |                |                       |                    |               |                    |             |  |
|                 |                      |          |          |                                  |          |                | -            |  |              |          |               |          |             | ı      |                |            |                |                       |                    |               |                    |             |  |
| SUMMARY .       | AND R                | CCOM     | MEND!    | TIONS                            |          |                |              |  | <del></del>  |          |               |          |             |        |                |            |                |                       |                    | · <del></del> |                    |             |  |
| For Q           |                      |          |          |                                  |          |                |              | 0  |              | 2.0 fee  |               |          |             |        |                |            |                |                       |                    |               |                    |             |  |
| For Q           | 50 =                 | 175 (    | cfs      | <b>Λ</b> P :                     | = 6.0    | 0 fps          | S            | 0  | <b>q</b> p = | 3.7 feet | t (n = (      | 0.045)   |             |        |                |            |                |                       |                    |               |                    |             |  |
|                 |                      |          |          |                                  |          |                |              |  |              |          |               |          |             |        |                |            |                |                       |                    |               |                    |             |  |
|                 |                      |          |          |                                  |          |                |              |  |              |          |               |          |             |        | •              |            |                |                       |                    |               |                    |             |  |

| /# +#-470<br>[Air 5:81]         |              |          |                  |             | С         | ıU:            | LV             | EF       | · T    | DE                                    | SIC              | ξŅ   | S                                     | 3H     | EET                  | -                |                |                   |               |               |                    | FEDERA       | ARTMENT OF THANSPORTATION<br>  MIGHWAY ADMINISTRATION<br>  TEN VANCOUVER, WASHINGTO |
|---------------------------------|--------------|----------|------------------|-------------|-----------|----------------|----------------|----------|--------|---------------------------------------|------------------|--|---------------------------------------|--------|----------------------|------------------|----------------|-------------------|---------------|---------------|--------------------|--------------|---|
|                                 |              | 7007     | <del>(61 +</del> |             | ·         |                |                |          |        | ****                                  | 1-C              |  |                                       |        | titvir               | 7164x            |                |                   |               |               |                    | _            | 1-C<br>. station  |
| C001_                           | Creek        |          |                  |             |           |                |                |          |        | 1.65                                  | 10.00            |  | _ 14 mat                              | PH.E1  |                      | MIXIMO           | <b>K</b>       |                   | $\overline{}$ |               |                    |              |   |
| usss                            | Quad -       |          |                  |             | on,       | 0rego          | on"            |          |        |                                       | :                | <u>.                                    </u> |                                       |        |                      |                  |                | /                 |               |               |                    |              |   |
|                                 | ,            |          |                  | ***         |           |                | 24             |          |        | 35                                    | 7E               |  |                                       |        | AH)T = _             |                  |                |                   |               |               |                    | \            | \   |
|                                 | 100          | 41144    | 1                |             |           | •              | 80             | £1100    |        | -                                     | BANA             | t.   | <b>46 1104</b> A                      | -      |                      |                  | 1              |                   |               |               |                    |              |   |
|                                 | <del></del>  | M        | 1-6-             |             |           |                |                | -        |        | 141                                   |                  |  |                                       |        |                      |                  |                |                   | •             | ~~~           | ~ <u> </u>         |              |   |
| <del></del> -                   | Brow         |          | g                | )T          |           |                |                |          |        | 11/3/                                 |                  |  |                                       |        | <u>arx 2014</u>      | <u>4.1</u> /     | <i>;</i>       | <br>50+.          | :0095         | <u>83</u> 7[. | 48'                |              |   |
| <u>••</u> 2 —                   | 145          | cfs      |                  |             |           | т              | <b>**</b> 2 '- |          |        | 2.0'                                  |                  |  |                                       | {      | REMARKS              | Grave            | ance 1         | l bou             | lders         | placed        | insi               | de the       | culvert barrel.   |
| Q+3+                            | 365          | çfs      |                  |             |           | 1              | '**** _        |          |        | 3.3'                                  |                  |  |                                       |        | Log and              | d-rock           | ( poo          | ls cor            | nstruc        | ted do        | wnstn              | eam fr       | om the culvert -  |
|                                 |              |          |                  | DES         |           |                |                | J        |        | <u> </u>                              |                  |  | Н                                     | EADW   | OUT let.             | COMI             | PUTAT          | HOI               |               |               |                    |              |   |
|                                 | , ,          | 2 1      | <u>`</u>         | FIFE<br>F   | I         |                | ş              | SIZE     |        | IKLET                                 | CONTROL          |  | · · · · · · · · · · · · · · · · · · · | ,      | ONITEL               | CONTR            | и ни           | (• H 1 No         | -L50          | ·             | <u> </u>           |              |   |
| SIZE<br>INCHES<br>Ka Cartikinal | CONCAETE *** | - 1      | 03831H           | STRUCTURAL  |           | NITENED        | C END SECTION  | D        | a      | D<br>HA                               | нw               | K.   | н                                     | đς     | ₫ <u>c</u> †0<br>2:  | T W              | h <sub>o</sub> | L3 <sub>o</sub> · | нж            | HW.<br>D      | COMT MOLLING<br>HW | OUTLET       | COMMENTS  |
|                                 | -            |          | $\neg$           |             |           |                | i              |          | tina   | nnmvie                                | A viote          | bol  | tho                                   | , nati | wal str              |                  |                |                   |               |               | 1                  |              |   |
| <u>14.7' s</u>                  | pan x y      | .5       | + r1             | <u>se a</u> | <u>cn</u> | ហបា            | rop o          | 1 100    | cing o | pproxiii                              | nery 4           | bero   | NY UTE                                | Jau    | nai Su               | Palli D          | <u>u.</u>      | ╁─                | ┼─            | 1—            | <del> </del>       | <del> </del> |   |
| Use equ                         | valent       | 1        | '-0'             | x 5         | -7"       | arch           | <u> </u>       | <u> </u> | ļ      | <u> </u>                              |                  | <u> </u>                                     |                                       |        |                      |                  |                |                   |               | <u> </u>      | ļ                  | <u> </u>     | Outlet velocity   |
|                                 | <sub>x</sub> | 1        |                  |             |           |                |                | 5.6      | 145    | 0.45                                  | 2.5              | 0.9  | 0.5                                   | 1.6    | 3.6                  | 2.0              | 3.6            | .46               | 3.6           | 0.6           | 3.6                | 5.6          | based upon TW   |
|                                 |              |          |                  |             |           |                | İ              |          |        |                                       |                  |  |                                       |        | 1                    |                  |                |                   |               | 1             |                    | 10.6         | Outlet velocity   |
| <del></del>                     | X            | $\dashv$ | $\dashv$         | —           |           | _              | <del> </del>   | 5.6      | 365    | 1.0                                   | 5.6              | 0.9  | 2.5                                   | 2.8    | 4.2                  | 3.3              | 4.2            | 1.46              | 6.2           | 1.1           | 6.2                | 8.6          | based upon TW   |
|                                 |              |          |                  |             | _         |                |                |          |        |                                       |                  |  |                                       |        |                      |                  |                |                   |               | <u> </u>      | <u> </u>           |              |   |
|                                 | 1. 1         | -        |                  |             |           |                |                |          |        |                                       |                  |  |                                       |        |                      |                  |                |                   |               |               |                    |              |   |
| SUMMARY .                       | AND RECE     | DUUI     | ENDA'            | TIONS       | <b></b>   | ·              | L              | L        | I      | · · · · · · · · · · · · · · · · · · · | l                | ·  |                                       | L      | <u> </u>             |                  |                | <u> </u>          | ·             |               | <u> </u>           |              | · · ·   |
| For Q2<br>For Q50               |              |          |                  | •           | Vb :      | = 4.6<br>= 6.3 | 6 fps<br>3 fps |          | 0<br>0 | db = 2<br>db = 5                      | .5 ft.<br>.6 ft. | (n = .<br>(n = .                             | .045)<br>.045)                        | in th  | ne culve<br>ne culve | rt bai<br>rt bai | mel.<br>mel.   |                   |               |               |                    |              |   |
| Note:<br>tail wa                |              |          | t ba             | rrel        | dep       | th ar          | nd vei         | locity   | cond   | itions a                              | re prob          | ably r                                       | nore r                                | repres | sentativ             | e of             | the o          | utlet             | cond          | itions        | than               | those        | based upon the  |

O BIL ENGLAY BURELLE LIN PRIME LINE . O LIGHT IL IN BRESENT

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| 7 R 60 - 814<br>(B.). 1 - 10 |                                      |                 |                 |             | C        | U       | LV           | EF                | <del>∵</del> | DE                 | :SIC        | ξŅ         | 8        | SH1        | EET  | -           |                |             |                  |                |                   | FEDERAL            | TWENT OF TRANSPORTATION<br>KIGHWAY ADHWISTRATION'S<br>N VANCOUVER, WASHINGTON |
|------------------------------|--------------------------------------|-----------------|-----------------|-------------|----------|---------|--------------|-------------------|--------------|--------------------|-------------|------------|----------|------------|--|-------------|----------------|-------------|------------------|----------------|-------------------|--------------------|---|
|                              |                                      |                 |                 |             |          |         |              | ·                 |              |                    | 1-D         |            |          |            |  |             |                |             |                  |                |                   | _                  | <u>1-D</u>  |
| Lost                         | Creek                                | (               | 1111            |             |          |         |              | •                 |              | 3.2                | Alband Adi  |            |          | -<br>Incti | treati   | MIKLMU      | w              | <del></del> |                  |                |                   | \                  | . STATION   |
| USGS                         | Quad                                 |                 | iinika<br>Will_ |             | Lake,    | _0re    | gon"         |                   |              | ;                  | AIRAGE AAI  | · <u>·</u> |          |            |  |             |                | /           | <b>/</b> .       |                |                   |                    |   |
|                              |                                      |                 |                 | har         |          |         | 21           |                   |              | 25                 | 8E          |            | •        |            | ANT -  | <del></del> |                |             |                  |                |                   |                    |   |
|                              |                                      | <u>i ačatic</u> |                 |             |          |         | • 1          | 6164              | •            | ******             | ***         |            | Préviés# |            |  |             |                |             |                  |                |                   | <del></del>        | <del></del>   |
|                              | Br                                   | างพกร           |                 |             |          |         |              |                   |              | 11/3/              | ′88         |            |          |            | J.<br>grx 237                                    | 15/         | / <u>:</u>     |             | . 014            | <u>~</u><br>亿. | <u> </u>          | <del></del>        |   |
| 9.0                          | . 25                                 | 55 cf           | S               | BT          |          | T       | W=0 '        |                   |              | 2.1                |             | ·          |          | _          |  | •           |                |             |                  |                | വിക്ക             | ——<br>d insid      | e the culvert   |
| 6.11<br>- 5 —                | 65                                   | :0 cf           | s               |             |          | ·<br>1  |              |                   |              | 3.5'               | <u></u>     |            |          |            | barrel   |             | <u> </u>       |             |                  |                |                   |                    | •   |
|                              |                                      | CUL             | VERT            | DES<br>PIPE | CRIP     | TION    |              |                   |              |                    |             | Y          | Н        | EADW       |  |             | PUTAT          | _           |                  | ·              |                   | <u> </u>           |   |
| SIZE                         | CCHCAETE<br>BROOVE-END<br>PROJECTING | ICCTING         | WITERED         | TRUCTURAL:  | VERTICAL | KITERED | END. SECTION | SIZE<br>D<br>FEET | Q.           | HA.<br>TKTEL       | SEW SEW     | к,         | н        | <b>4</b> c | 4c10   | TW          | h <sub>o</sub> |             | -LS <sub>0</sub> | HW.            | CONTROLLING<br>NW | VELOCITY           | CONNENTS  |
| Xa Coellician +              | 5.0                                  | 0.9             | 7.0             | 0.7         |          | 1.0     | 0.5          | 0_                | <u> </u>     |                    | <del></del> |            |          |            | ļ  | 0           | 0              |             | <u> </u>         |                | 8                 | 0 <del>5</del>   . |   |
| 18.2' s                      | pan x                                | 5.6             | ' ri            | se ar       | ch w     | ith     | expose       | d cor             | crete        | footing            | s (2.5      | to 3       | 5' ve    | rtic       | expos  | ure)        |                |             |                  |                |                   |                    |   |
| Use equ                      | ivald                                | nt 1            | 3 <b>.</b> 2'   | spar        | x 9      | 11'     | rise .       |                   |              |                    |             |            |          |            |  |             |                |             |                  | ;              |                   |                    | ·   |
|                              |                                      | <u></u> -       |                 |             |          |         |              | 9.1               | 255          | 0.35               | 3.2         | 0.9        | 0.5      | 2.0        | 5,6  | 2.1         | 5.6            | 0.7         | 5.4              | 0.59           | 5.4               | 6.5                | Outlet velocity<br>based upon TW  |
| <del></del>                  |                                      | X               |                 |             |          |         |              |                   | 655          | 0,65               | 5.9         | ]          | 1.3      | i —        |  |             | <u>[</u>       |             |                  | 0.75           |                   |                    | Outlet velocity<br>based upon TW  |
|                              |                                      |                 |                 |             |          |         |              |                   |              |                    |             |            |          |            |  |             |                |             |                  |                | -                 |                    |   |
|                              | <u> </u>                             |                 |                 |             |          | -       |              |                   |              |                    |             |            |          | -          | <del>                                     </del> |             |                |             |                  |                |                   |                    |   |
| SUMMARY .                    | AND R                                | ECOM            | MEHOA           | LTIONS      | I        |         |              | <del>1</del>      | <del></del>  | l                  | <u> </u>    | ·          | l        | L          | <del> </del>                                     | L           |                |             | l                | !              |                   | <u> </u>           |   |
| For Q2<br>For Q50            |                                      |                 |                 | Vb =        |          |         |              |                   |              | 2.5 ft.<br>4.7 ft. |             |            |          |            |  |             |                |             |                  |                |                   |                    |   |

Note: The culvert barrel depth and velocity conditions are probably more prepresentative of the outlet conditions than those based upon tail water depth.

O 621 CHIETER GIRBLETE THE BOMES BIELE -

|  |                     | CULVERT  | /EI      | L<br>L   | DE                                | DESIGN                                    | Z        | $\overline{o}$  | SHEET                     |  |                     |   |                    |  |             | PERCALL<br>PERCALL<br>US DEPA                 | UP DEPAINENT OF TRANSPORTATION FEDERAL HIGHWAY SOMMITTATION ALENDATE, WASHINGTON |
|--|---------------------|--|----------|----------|-----------------------------------|---|----------|---|---------------------------|--|---------------------|---|--------------------|--|-------------|---|--|
| Polallie Creek   | 740,461 14W         |  |          |          | C-7                               |   |          |   | <br>                      | MILE STATE                                       | TATION<br>E NINCHEN |   |                    |  |             |   | (-7<br>1/4/10 K  |
| USGS Quad - "Dog   | "Dog River"         |  |          |          |                                   | 4344 A4E4                                 |          |   |                           | <u> </u>   |                     |   |                    |  |             | /   |  |
|  | 1                   |  | 5        |          | X                                 | 10E                                       |          |   |                           | <br>- <u>*</u>                                   |                     |   |                    |  |             |   |  |
| :  |                     |  |          | -        |                                   |   |          |   |                           |  |                     | 1   |                    |  |             |   | <u> </u>   |
| Browning   |                     |  |          |          | 11/3/88                           | 88  | <u> </u> |   | <br>I                     | _   §  |                     |   | .   }              | }   <u>-</u>                           | 3           |   | <u> </u>   |
| 9.0 425 cfs  | <b>.</b>            | \$ E   |          |          | 3.31                              |   |          |   |                           | 7.2082)<br>(2802.2                               | 700 S               | 6. 4. 5. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. | 002                | (2802.2) (-34-34-71) (-34-17) (-34-17) |             | و<br>+<br>غ ا_                                | 51)<br>for the 84" (NO (2798.9)  |
| 1090 cfs   | ړ                   | · • • • • • • • • • • • • • • • • • • •  | _        |          | 4.7                               |   |          |   |                           | 2'+ de   |                     | or ho   | le is              | ocated                                 | at th       | 2'+ deep scour hole is located at the outlet. |  |
| CULVE  | ERT DESCH           | DESCRIPTION  |          |          |                                   |   |          | HE/   | HEADWATER                 |  | OMPO                | COMPUTATION                                     | 1 1                |  |             |   |  |
|  |                     |  |          |          | וארנו                             | CONTROL                                   | Ì        | Ì   | ٦                         | OUTLET C   | COXINGL             | HW•H176   | 1 ho - L So        |  |             |   | •  |
| SIZE INCHES CONCRETE CONCRETE CONCRETE CONCRETE CONTRIBUTE CONTRIB | PRACTURA<br>TAMA C. | YERTICAL  SHITERES  SHORES  CHAPTER  CH | 2 17E    | 0        | A A                               | H.W                                       | ×        | Ξ   | 21                        | 440  | <b>≯ 0</b>          | ه م   | LS <sub>0</sub> HW | HT.                                    | CONTROLLING | VELOCITY                                      | COMMENTS   |
| 12.7' × 7.25' OP-  | -and with           | OP-anth with concrete-1 ned invert   | <u>-</u> | nvert    | A] SO                             | 84" CMP                                   |          | flood relief pipe   | f pig                     |  |                     |   | 1                  |  |             |   |  |
| 12.7' × 7.25'  | ×                   |  | 7.2      | 7.25 690 | 1.3                               | 9.4                                       | 0.7      | 3.0   | 5.0 6                     | 6.1  | 4.7                 | 6.1   | 4.7 4.4            | 0.6                                    | 9.4         | 8)<br>5.                                      |  |
|  | ×                   |  |          | 400      | 1.4                               | 9.6                                       | 0.7      | 4:5   | 5.25 6                    | 6.1  | 3.3 (               | 6.1 3.  | 3.3 7.3            | 1.0                                    | 9.8         | 19.0  | ,  |
| 12.7' × 7.2\$'   | ×                   |  | 7.25     | 5 625    | 9.0                               | 4.4                                       | 0.7      | 0.5   | 3.0 5                     | 5.1  | 4.7                 | 5.1 4.  | 4.7 0.9            | 0.1                                    | 4.4         | .21.5   |  |
| 18   | ×                   |  | 7        | <u>8</u> | 0.7                               | 4.9                                       | 0.7      | 0.7   | 3.3 5                     | 5.2  | 3.3                 | 5.2 3.  | 3.3 2.6            | 0.4                                    | 4.9         | 15.0  |  |
|  |                     |  |          |          |                                   |   |          |   |                           | <del>                                     </del> |                     |   | <u> </u>           |  |             |   |  |
| SUMMARY AND RECOMMENDATIONS  | NDATIONS            |  |          |          |                                   |   |          |   |                           |  |                     |   |                    |  |             |   |  |
| For Q2 = 265 cfs<br>For Q60 = 690 cfs<br>For Q2 = 160 cfs  | 8888                | Vb = 21.5 fps<br>Vb = 29.5 fps<br>Vb = 15 fps  | ଜନ୍ନ     | 8.8€€    | 2.2 ft.<br>2.3 ft.                | (n = 0.015)<br>(n = 0.015)<br>(n = 0.024) |          | for 12.7'x 7.25' pipe arch barrel for 12.7'x 7.25' pipe arch barrel for 84' QMP culvert barrel. | 7.×.7<br>7.×.7<br>9.9 9.9 | 35' pig  | e arr<br>barred     | pipe arch barrel pipe arch barrel srt barrel.   | 면 면                |  |             |   |  |
| \$15 PM   PP   PP   PP   PP   PP   PP   PP   | 1 0                 | ed .   | ע        |          | );<br>-<br>-                      | ı   |          | 5<br>5  |                           | יו אפו ר   | <u> </u>            |   |                    |  |             |   |  |
| O use courtil plugitel ses noch ever   | . 1941              | the court na   | inti,    | 5 E      | 0 % 15 11 11/11 11<br>fell 110 11 | <u>_</u>                                  |          |   |                           |  |                     |   |                    |  |             |   |  |

| 14 10 114  | -  |                              | -             |                                |                 | ,              |                     | -  |                  |                  |                       |  |                   |                 |                      |                          | ļ.          | 10 50    | US DEPARTMENT OF TRANSPORTATION                    |
|--|--|------------------------------|---------------|--------------------------------|-----------------|----------------|---------------------|--|------------------|------------------|-----------------------|--|-------------------|-----------------|----------------------|--------------------------|-------------|----------|--|
|  |  |                              | Ö             | CULVERT                        | /EF             | <del> </del>   |                     | DESIGN                                     | Z                | ഗ                | Π                     | SHEET  |                   |                 |                      |                          |             | ACCION   | TER VANCONTA, WASHINGTON                           |
|  |  | ,                            |               |                                |                 |                | 14-A                |  |                  |                  |                       |  |                   |                 |                      |                          |             |          | 14-A   |
| Motte  | Mottet Creek   | ler.                         |               |                                |                 |                | 10.8                |  |                  |                  | · 5                   | 1, 1, 1, 1, 1                                    | E' KININUM        |                 |                      |                          |             | '<br>/   | STATION  |
| SBSO   | USSS Quad - "Jubilee Lake"   | Jubilee La                   | as            |                                |                 |                | <del> </del>        | ,  | <u>.</u>         |                  |                       | <u> </u>   |                   |                 |                      |                          |             | /        |  |
|  | 1.   | 3                            |               | "                              | 83              |                | ₹                   | 335  |                  |                  |                       | — <del>}</del>                                   |                   | 1               |                      |                          | -           |          |  |
|  | 10(4104  |                              |               | <u> </u>                       | 111111          |                | 1674380             | ) in                                       |                  | ECTION A         | 1                     |  |                   | 1               |                      |                          |             |          |  |
|  | Browning   |                              |               |                                |                 |                | 11/7/88             | 88   |                  |                  | 1                     | _  }   |                   |                 |                      |                          |             |          | 1  |
| 6.6  | 1_   | =                            |               | \$<br>#                        |                 |                | 3.0'                |  |                  |                  | ਤੌ <sup>1</sup> :<br> | 9003.C   | , is              | 4. 4. to        | Gree-So- CoUS/3 /, U | 7 7 2                    | · -         | 2        | Account of analyse within the cut let area of the  |
| <br>   | 375 cfs  |                              |               | 7                              |                 |                | 4.9'                |  |                  |                  | ¥ ∂<br>               | quivert.   |                   | sition          | and single           | a at                     | a sla       | ormed t  | Deposition is due to pools formed by log barriers. |
|  | CULVERT DESCRIPTION  | T DES                        | CHIPT         | ОН                             |                 |                |                     |  |                  | 포                | HEADWATER             | EA   | COMPU             | COMPUTATION     | ٦                    |                          |             |          |  |
|  |  | 1                            |               |                                |                 | <u></u>        | INLET (             | COXTABL                                    |                  |                  |                       | OUTLET C   | CONTROL           | HW . H f ho     | 1 ho - L So          |                          |             |          | •  |
| SIZE<br>SKCHEN<br>CONCRETE<br>CONCRETE<br>CONCRETE | #17310A4 %   | ANUTURIZ<br>TAJA<br>TORITIES | JADITABY &    | ITSSE ONS SECTI                | 3 a 1 a         | 0              | H.K.                | HW   | ₹.               | ×                | 4                     | 4+0  | <b>≱</b> •        | ه مي            | LS <sub>0</sub> HW   |                          | CONTROLLING | VELOCITY | COMMENTS   |
| 5*-8" >  | 7'-0" X  |                              |               |                                | 7               | 125            | .55                 | 3.9  | 0.7              | 0.5              | 3.2                   | 5.1  | 3.0               | 5.1 6           | 6.3                  |                          | 3.9         | 16.4     | Barrel Velocity                                    |
| 5'-8" >  | 7'-0" X  |                              |               |                                | . 7             | 375            | 1.35                | 9.5  | 0.7              | 4.0              | 6.0                   | 6.5  | 4.9               | 6.5             | 6.3 4.2              | 9.0                      | 9.5         | 5 20.5   | Barrel Velocity                                    |
|  |  |                              |               |                                |                 |                |                     |  |                  |                  |                       |  |                   |                 |                      |                          |             |          |  |
|  |  |                              |               | <u> </u>                       |                 |                |                     |  |                  | <u> </u>         |                       |  | -                 |                 |                      |                          | -           |          |  |
|  |  |                              |               |                                |                 |                |                     |  |                  |                  |                       |  |                   |                 |                      |                          |             |          |  |
|  |  |                              |               |                                |                 |                |                     |  |                  |                  |                       |  |                   |                 |                      |                          |             |          | ,  |
| SUMMARY  | SUMMARY AND RECOMMENDATIONS  | ATIONS                       |               |                                | -               | ]              |                     |  |                  |                  |                       | 1  | 1                 |                 |                      |                          |             |          |  |
| For 02<br>For 050                                  | For Q2 = 125 cfs<br>For Q50 = 375 cfs  |                              | ₽<br>₽<br>₽   | Vb = 16.4 fps<br>Vb = 20.5 fps | 75<br>75<br>75  | ଭ ଭ            | G= 2.<br>G= 3.      | 2.0 ft. (n = 0.024)<br>3.6 ft. (n = 0.024) | n = 0.<br>n = 0. | 024)             | for<br>to<br>th       | for the culvert barrel<br>for the culvert barrel | ert ba<br>ert ba  | rrel.<br>rrel.  |                      |                          |             |          |  |
| Note:<br>outlet                                    | Note: The culvert barrel velocity and depth are representative for the first 80'+ of culvert length. outlet is controlled by the log pool. This is supported by the evidence of stream bed deposits within | Samel<br>1 by t              | velo<br>fe lo | city ar<br>g pool.             | rd dept<br>This | chare<br>issug | represer<br>oported | ntative<br>by the                          | for the          | ne fir<br>nce of | st 80'<br>strea       | + of cu  | Ji vert<br>Jeposi | lengt<br>ts wit | h. Th                | The 30' of<br>this area. | of cul      | vert le  | The 30' of culvert length mear the this area.      |
| 9 151 CM1(4)                                       | G 151 tolifet lientife tes bibes fulfills  | 2113                         | 141           | Circle is successfully         | i i             | 6 % T          | Oby n til pitili if | _  |                  |                  |                       |  |                   |                 |                      |                          | .           |          |  |
|  | •  |                              |               |                                |                 | ٠              |                     |  |                  |                  |                       |  |                   |                 |                      |                          |             |          |  |

| CULVERT DESIGN S   | SHEE   | <br> -                              |                |                         |             |                   | US OCTA<br>FEDERAL<br>REBION T | US OFFARINENT OF TRANSPORTATION FEDERAL MINNERS ADMINISTRATION ALBUM TEN VANCOUVER, WASHINGTON |   |
|--|--|-------------------------------------|----------------|-------------------------|-------------|-------------------|--------------------------------|--|---|
| 14-B  Little Lookingglass Creek 18.2  Indian nim   |  | #0.4 m.m3                           |                |                         |             |                   |                                | 14-8<br>174710M  |   |
| USSS Quad - "Jubilee Creek"  2 3N 39E  | <u>\$</u><br>  |                                     |                |                         |             | j                 |                                |  |   |
| Browning 11/7/88  9-2 195 cfs 1**2   |  | Are 2959.3 Com-sa-0.0164.7. to 1107 | cust<br>ls and | 604-50-02:0164-/- 1-110 | 34.1/1.80 S | Se th             | stree                          | m bed of the   |   |
| 560 cfs  | arch   | ch.                                 |                |                         |             |                   |                                |  |   |
| CULVERT DESCRIPTION METAL PIPE PELDWALLS EN ET CONTROL   | HEADWATER  | ۱ ۱                                 | 151            | FATION                  |             |                   |                                |  |   |
| 0. \$400×5€116<br>0. \$400×5€100<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×510<br>0. \$1120×50<br>0. \$11 | 3  |                                     | ) ~            | H. H.                   | ME TILL     | CONTROLLING<br>HW | OUTLET<br>YELOCITY             | COMMENTS   |   |
| 17'-6" x x 8'-1' x 8.1 195 0.3 2.4 0.9 0.5   | 1.6 4.9  | 1.4                                 | 4.9            | 1.8 3.6                 | 5.0.4       | 3.6               | 10.3                           | Based upon dc.   |   |
| 17'-6" x x 8'-1" x 8.1 560 0.65 5.3 0.9 2.1  | 3.4 5.9  | 2.1                                 | 5.9            | 1.8 6.2                 | 9.0         | 6.2               | 11.9                           | Based upon dc.   |   |
|  |  |                                     |                |                         |             |                   |                                | ,  |   |
|  |  |                                     |                |                         |             |                   |                                |  | - |
|  |  |                                     |                |                         |             |                   |                                |  |   |
|  |  |                                     |                |                         |             |                   | !                              |  |   |
| subuking and accompliances $0$ db = 2.4 ft. ( $n$ = 0.045) for the culvert barrel For $0.050$ = $0.065$ for the culvert barrel For $0.050$ = $0.065$ for the culvert barrel  | he culvert<br>he culvert   | barrel.                             | į              |                         |             |                   |                                |  |   |
| Note: Gabion weir may reduce outlet velocities during high flows. The bar velocities than those computed using dc.   | The barrel velocities are probably more representative of outlet | ities ar                            | a prot         | ably mo                 | na<br>Tepra | esenta            | tive of                        | Foutlet  |   |
| O by contre pinetic to the roll of openity of the ballon, or the cities of the ballon of the bold angular file and the contress of the contress of the ballon of the ballo   |  |                                     |                |                         |             |                   |                                |  |   |
|  |  |                                     |                |                         |             |                   |                                |  |   |

E-7

| 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  |                  |                | 1.   |   |  |          |       |  |                         |                   |             |                    |          |             | 10 EQ                    | PARTMENT OF TRANSPORTATION   |
|--|------------------|----------------|--|---|--|----------|-------|--|-------------------------|-------------------|-------------|--------------------|----------|-------------|--------------------------|--|
|  | CULVERT          | 냅              | 7  | DE  | DESIGN   | Z        | (J)   | SHEET  | 닏                       | .•                |             |                    |          |             |                          | FEBERL HIGHWAY ABMMAN MASHINGTON,<br>REGION TEM YANGOVER, WASHINGTON |
|  |                  |                |  | 15-A  |  |          |       | ļ. <u>.</u>                                      |                         |                   |             |                    |          |             |                          | 15.A   |
|  | to Chesnimus Cr. | ئى .           |  | 2.0   |  |          |       | ·  | E LEVATION              | Vation 2' Minimum |             |                    |          |             |                          | . БТАТЮИ   |
| "unped) edemail - perio 3(5)?  |                  |                |  | <b>.</b>  | vive Secured   | <u>.</u> |       |  |                         |                   |             | 1                  |          |             | /                        |  |
| Votes (und - unitaria, orespond  |                  |                |  | 1.  | 1  |          |       |  | — <b>į</b>              |                   | 1           |                    |          | •           |                          |  |
| 9912781  | <b>₹</b>         | ×1,1110        |  | <b>4</b>  | 4/1  |          |       |  |                         |                   | 1           |                    |          | j           |                          |  |
| HIGHE  |                  |                |  | ) I V (   |  |          |       | 1  | _                       |                   |             |                    | {        | <b>\{</b>   |                          |  |
| Browning<br>Cutette at   |                  |                |  | 11///88<br>   | 88   |          |       | <u>,</u>   | 9 <del>14 4356</del> ,6 | 3.                | Craft-5a.   | - 1                | 032617   | g.          |                          | nr. 4355.6   |
| 6.2 55 cfs   | 7 4              |                |  | 1,4'  |  |          |       |  | ACKARKI                 |                   |             |                    |          |             |                          |  |
| 1  | 1 2              |                |  |   |  |          |       |  |                         |                   |             |                    |          |             |                          |  |
| EULVE KI   | 1                |                |  | IKLET C   | COXTROL  |          | =     | HEADWAILER<br>OUT                                |                         | CONTROL           | COMPUTATION | 1 Po - LS          | ۱.       | -           |                          |  |
| Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z  | END SECTION      | D D            | 0  | 1   | *  | ٠,       | Ξ     | ÿ  |                         | <b>≥</b> •        | ه م         | LS <sub>0</sub> HW | <u> </u> | CONTROLLING | WW<br>OUTLET<br>VELOCITY | COMMENTS   |
| <del>   </del>   |                  | 3.9            | Ξ  | 0.3   | 1.2  | 0.9      | 0.1   | 0.8  | 2.4                     | 90                | 2.4         | 1.0 1.5            | 5 0.4    | 4 1.5       | 5 5.5                    | Barrel Velocity  |
| 5.0' x 3.9' X  |                  | 3.9            | 52   | 0.7   | 2.7  | 0.9      | 0.4   | 1.5  | 2.7                     | 1.4               | 2.7         | 1.0 2.1            | 0.5      | 5 2.7       | 7 9.6                    | Barrel Velocity  |
|  |                  |                |  |   |  |          |       |  |                         |                   |             |                    |          |             |                          |  |
|  |                  |                |  |   |  |          |       |  |                         |                   |             |                    |          | <u> </u>    |                          |  |
|  |                  |                |  |   |  |          |       | <u> </u>   |                         |                   |             |                    |          |             |                          |  |
|  | ļ                |                |  |   |  |          |       | -  | <del>  —</del><br>      |                   | -           |                    |          | ļ<br>Ī      | <br>                     |  |
| SUBLARY AND ACCOMMENDATIONS FOR Q2 = 11 cfs Vb = 5.5 fps For Q50 = 55 cfs Vb = 9.6 fps | 00               | <del>8 9</del> | = 0.5 ft<br>= 1.2 ft   | ft. (n = (<br>ft. (n = (                                | 0.024) for the culvert barrel.<br>0.024) for the culvert barrel. | for t    | e cul | for the culvert barrel<br>for the culvert barrel | arrel.<br>arrel.        | 1                 | †           |                    | <br>     |             | 1                        |  |
| Note: The culvert barrel does not significantly  | not signi        | ifical         |  | constrict the natural                                   | the na   | tural    | strea | stream charmel.                                  | re].                    |                   |             |                    |          |             |                          |  |
| VI EIST STREETSTOF FOL DESSE SPEECE CONTROLS - DESCEN                                  | EINT CHAIR HAN   | '              | 0<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2<br>2 | 1 11 11 11 17 19 10 10 10 10 10 10 10 10 10 10 10 10 10 | _  | i        |       | ,  |                         |                   |             |                    |          |             |                          |  |

E-8

| Intraha Intrah | CULVERT  | VE.        | RH      | С<br>Гт                |   | Z                | Ū              |  | ŀ          |              |           | •        |            | : E                          | STOR TER   | READM TEN VANCONER, PASKINGTON |
|--|--|------------|---------|------------------------|---|------------------|----------------|--|------------|--------------|-----------|----------|------------|------------------------------|------------|--------------------------------|
| uth Fork Chesnimp  SS Quad - "Imraha  Browning  Cucue F  107 cfs  LETAL F  |  |            |         | ]                      | 5                                       | 7.               | Ō              | ֡֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟                                    | <b>-</b> : |              |           |          |            |                              |            |                                |
| uth Fork Chesnims  SS Quad - "Imraha  Browning  Cutoffs  107 cfs  Lutter F   |  |            |         | 15-8                   |   |                  |                |  |            |              |           |          |            |                              |            | 15-8                           |
| SS Quad - "Imraha  Luctrine  Browning  Crector  23 cfs  107 cfs  | s Cheek  |            |         | 4.8                    |   |                  | 1 mar 1 mar 11 |  | E MINIMOR  | ¥ 5          |           |          |            |                              |            | 81A110H                        |
| Browning create a 23 cfs 107 cfs 107 cfs   | Oregon"  | •          |         | •                      | *************************************** |                  |                | -  |            |              | 1         |          |            |                              | /          |                                |
| Browning create a 23 cfs 107 cfs   | •  | 24         |         | Ŕ                      | -:<br>4Æ                                |                  |                | — ≹<br>  |            |              | \         |          |            |                              | /          |                                |
| Browning create 23 cfs 107 cfs   |  | 110164     |         | 10 4 4 4 4 4           | BANGE                                   |                  | MENHAR         | <u> </u>   |            | 1            |           |          |            |                              |            | ļ                              |
| 23 cfs<br>107 cfs  |  |            |         | 11/7/88                | x2                                      |                  |                | <del></del> {  | ,          | $\downarrow$ |           |          | }          |                              |            |                                |
| 107 cfs  | 3 M  |            |         | 0.6                    |   |                  |                | - 0.02 <u></u>   | arr424/13, | 3            | Crack-5e. | -1 / OFT | }<br>:<br> | - P                          | 1 "        | A546.2                         |
|  | 7  | \          |         | 1.3'                   |   |                  |                | REKARKS:   |            |              |           |          |            |                              |            |                                |
| TK LAL   | 100  | $\mid$     |         |                        |   |                  | HEA            | HEADWATER  | 100        | COMPUTATION  | NON       |          |            |                              |            |                                |
| 91   | FEADWALLS  |            |         | INLET C                | COXINOL                                 |                  |                | OUTLET   | ET CONTROL |              | HW-H+ho-  | ٠٢٥,     |            |                              |            |                                |
| NE CATTRIAN - 0.5 P. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. D. S. S. D.  | MUTTURIZ C. L. L. L. L. L. L. L. L. L. L. L. L. L. | 1332 OH3 S | 0 ,     | NA C                   | НЖ                                      | ×.               | I              | \$<br>₽12  | ž •        | 2 0          |           | <u>*</u> | 134 Mg     | CONTROLLING<br>HW<br>CONTRET | VELOCITY . | COMMENTS                       |
| 6.7' X   |  | 6.7        | 23      | 0.25                   | 1.7                                     | 0.7              | 0.1            | 1.0 3.9  | 9.0        | 3.9          | 1.1       | 2.9      | 0.4        | 2.9                          | 8.0 B      | Barrel Velocity                |
| 6.7' X   |  | 6.7        | 107     | 9.0                    | 4.0                                     | 0.7 0            | 0,3            | 2.75 4.7   | 1.3        | 4.7          | 1.1       | 3.9      | 9.0        | 4.0                          | 12.5 B     | Barrel Velocity                |
| -  | -  |            |         |                        |   |                  |                |  |            |              |           |          |            |                              |            |                                |
|  |  |            |         |                        |   |                  |                |  | _          |              |           |          |            |                              |            |                                |
|  |  |            |         |                        |   |                  | ļ<br>          |  |            |              |           |          |            | -                            |            |                                |
| -  |  |            |         |                        |   |                  | -              |  |            |              |           |          |            |                              |            |                                |
| SUMMARY AND RECOMMENDATIONS FOR Q2 = 23 cfs For Q50 = 107 cfs Wb =   | No = 8.0 fps<br>No = 12.5 fps                      | 6.0        | 9 9     | 0.9 ft. (<br>2.0 ft. ( | (n = 0.0<br>(n = 0.0                    | 24) fc<br>24) fo | or the         | (n = 0.024) for the culvert barrel.<br>(n = 0.024) for the culvert barrel. | barrel     |              | 1         |          |            | -                            |            |                                |
| Note: The culvert does not significantly constrict the natural stream channel.   | s not signifi                                      | cantly     | constri | ot the na              | tural s                                 | tream            | chann          |  |            |              |           |          |            |                              |            |                                |
| 500 taxes tot 1717am 1117am 520  | -  |            | 2       |                        |   |                  |                |  |            |              |           |          |            |                              |            |                                |
| DEC 1151 HALKSIDE THE AICH CHUCKES   | נושו נוואנו ווזוו                                  |            |         |                        |   |                  |                |  |            |              |           |          |            |                              |            |                                |

:

| 111.0  | 1 0 d > = 0                  |            | l h                | ני  | 70.01        | 2        | U           |                              | -                     |                |              |                  |       |                 | US OCFAL<br>FEBERAL<br>ACCOM | US DEFABLICATION OF TRANSFORFATION FEDERAL HIGHER TODAYEN, WASHINGTON RESON TEN VANCOUVEN, WASHINGTON |
|--|------------------------------|------------|--------------------|---|--------------|----------|-------------|------------------------------|-----------------------|----------------|--------------|------------------|-------|-----------------|------------------------------|---|
|  | )                            | -          | -                  | ָ<br>֡֝֝֝֝֡֝  | 0 0          | 2        | Ď           | ֡֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝֟֝ | <br>                  |                |              |                  |       |                 |                              |   |
|  |                              |            |                    | 9-0   |              |          |             |                              |                       |                |              | . ,              |       |                 |                              | <u>.</u>  |
| Devil's Run Creek  | J=:                          |            |                    | 6.]   |              |          |             |                              | Erration   P. Control | 3              |              |                  |       |                 | l                            | STATION   |
|  | Jan V m                      |            |                    |   | vive Henred  | _        | 13 MAT BALE | 5                            |                       |                |              | \                |       |                 | /                            |   |
| USS Quad - "Poison Point.                                    | Point, Oregon"               | _          |                    |   |              |          |             | I                            |                       |                | `            |                  |       |                 | /                            |   |
|  | 2                            | ۳          |                    | 8   | 4 <i>T</i> E |          |             | - <del>\$</del> -            | <br> - <u> </u>  -    |                | \            |                  |       |                 |                              |   |
| 10117)01   |                              | 101311     |                    | 100.140   | 11.17        |          | BE RIBLAR   |                              |                       |                |              |                  |       |                 |                              |   |
| 4)*1)124   |                              |            |                    | 3170  |              |          |             | ·<br>·                       |                       | 7              |              | \<br> <br>       | }     | t               |                              | 1   |
| Browning the trace of  |                              |            |                    | 88///I  | × <br>       |          |             | 를<br>[                       | nr 4386.1             | \<br>\         | C14-5-       | 0.0135'/'1. 44:3 | 5,7,0 | 44.3            |                              | 4385.5  |
| 4.2 28 CFS   | 7*7                          | 2          |                    | 0.9   |              |          |             | - ACMARKE                    |                       |                |              |                  |       |                 | .                            |   |
| 129 cfs  | 181                          |            | İ                  | 1.9'  |              |          |             | ·                            |                       |                |              | İ                | į     |                 |                              |   |
| TORNING  | DESCRIPTION                  | -          |                    |   |              |          |             | - 1                          |                       | 1,14           |              |                  |       |                 |                              |   |
| TOTAL TOTAL  | PE PEABWALLS                 | HK         |                    | אונו  | CONTROL      |          | Ž           | ACAUMAI EN                   |                       | CONTROL HW-MI  | HW-H1h       | 1.50             |       |                 |                              |   |
| CONCRETE<br>#NOUNCETH<br>PROUECTING<br>PROUECTING<br>WITERED | VERTICAL<br>WITERED          | SY O STATE | о .<br>Ш           |   | HW           | ×        | =           | 2,2                          |                       |                | 1.30         | ₹ .              | HW.   | HTAOLLING<br>WH | TIOCITY                      | COMMENTS  |
| X4 Cartikins - 0.2 0.9 0.7                                   | 1.0 2.0                      | 0.5        |                    |   |              |          |             | -                            | -                     | •              | $\downarrow$ |                  |       | юэ              | ^                            |   |
| 10.2' x 4.5' X   |                              | 4.5        | 8                  | 0.25  | 7.7          | 0.7      | 0.3         | 0.7 2.6                      | 0.9                   | 9 2.6          | 9.0          | 2.3              | 0.5   | 2.3             | 4.5                          | Based upon 7W   |
| 10.2' × 4.5' X   |                              | 4.5        | 129                | 0.60  | 2.7          | 0.7      | 0.          | 1.6 3.1                      |                       | .9 3.1         | 9.0          | 3.5              | 0.8   | 3.5             | 8.2                          | Based upon TW   |
|  |                              |            | ,                  | •   |              |          |             | <del></del>                  |                       |                |              |                  |       |                 |                              |   |
|  |                              | }          |                    | -   |              | -        |             |                              |                       |                |              |                  |       |                 |                              |   |
|  |                              |            |                    |   |              | $\vdash$ | -           |                              |                       | -              | -            |                  |       |                 | 1                            |   |
|  |                              | ļ          |                    |   |              | <u> </u> | <u> </u>    |                              |                       | <u> </u><br>   | <u> </u>     |                  |       |                 | ,                            |   |
| SUMMARY AND RECOMMENDATIONS                                  | SNOI                         |            |                    |   |              | 1        |             | $\frac{1}{2}$                |                       | -              |              |                  |       |                 | 1                            |   |
| For Q2 = 28 cfs<br>For Q50 = 129 cfs                         | Vo = 3.7 fps<br>Vo = 5.7 fps | ତ ଡ        | 9 <del>8</del> = 1 | 1.1 ft. ( $n = 0.040$ ) for the culvert barrel 2.5 ft. ( $n = 0.040$ ) for the culvert barrel | in = 0.0     | 740) fo  | ir the      | cul vert                     | barre<br>barre        | <i>-: .</i> :: |              |                  |       |                 |                              |   |
| Note: The barnel velocity is more representative             | city is more                 | reprreser  |                    | of the outlet velocity for this culvert.  | outlet \     | eloci    | ty for      | this cu                      | l vert.               |                |              |                  |       |                 |                              |   |
| O 15f buffil startit fit 1986 forth                          | 1 . 6741-17 IS tunter        | una,       | 20                 | וון מנוזט זון   | _            |          |             |                              |                       |                | -            |                  |       |                 |                              |   |
| psi list biafnston fol pica cotaft                           |                              | 11711      | - TET              | =<br>=  |              |          |             |                              |                       |                |              |                  |       |                 |                              |   |

| 111111111111111111111111111111111111111                                       |              | '             |                                  |                               |              |                  |         |               | -         | 1.                         |            |            |              |  | 1                    |             |        |                           |                  | -               | . DCP44  | TWENT OF TRANSPORTATION  |
|---|--------------|---------------|----------------------------------|-------------------------------|--------------|------------------|---------|---------------|-----------|----------------------------|------------|------------|--------------|--|----------------------|-------------|--------|---------------------------|------------------|-----------------|--|--|
|   |              |               | ٠.                               | 0                             | 5            | >,               | CULVERT | <b>L</b> ~    | DE        | DESIGN                     | Z          | U)         | Ĭ            | SHEET  |                      |             |        |                           |                  |                 | 71 HOID 16                                       | FEDERAL, MISNWAT ADMINISTRATION,<br>REGION IEM VANCOLVER, WASHINGTON |
|   |              |               |                                  |                               |              |                  |         |               | C-3       |                            | }          |            | <del> </del> |  |                      |             |        |                           |                  |                 |  | ر ا  |
| Billy Creek   | 1 .          | 3m13 1316044  | 1                                |                               |              |                  |         |               | 10.7      |                            |            |            | · .          | ELEVATION II.                                    | E' WIKINUK           |             |        |                           |                  |                 | l  | 41ATION  |
| USS Orad - "Poison Point,   | P            | Poj so        | Poj son Poj                      |                               | Oregon"      | -E               |         |               | <b>1</b>  |                            | <u>.</u> . |            |              | ļ  |                      |             | 1      |                           |                  |                 |  |  |
|   |              |               | 3                                |                               |              | ~                |         |               | ≅         | 47E                        |            |            |              | k-   |                      |             | \      |                           |                  |                 | /  |  |
|   | 14117391     | I             |                                  |                               |              | Ĕ                | 110101  |               | 104444    | 7741                       |            | P.C.AIDAAH | _            |  |                      | V           |        |                           |                  |                 |  |  |
|   | Browning     | รรณะเล        |                                  |                               |              |                  |         |               | 11/8/88   | 88                         |            |            |              |  |                      | J           |        |                           | }                |                 |  |  |
| 0.0   | 45 cfs       | totales<br>fs | E                                |                               | •            | . 57 34          |         |               | 1.9.1     |                            |            |            |              | 9.03.3876.4<br>T                                 | 5.4                  | 2           | 1 1    | Code-50. 0.228 // t. 78:8 | /<br>/<br>!<br>! | 89<br>88<br>188 |  | 3874.6   |
|   | 197 cfs      | <u>3</u>      |                                  | .                             | :            | 7 . <del>1</del> |         |               | 3.0'      |                            |            |            |              | BEKARKI.   | 1 1                  | ADOME       |        | (6.3" × 5.0" pipe-arch)   | <b>1</b> (3)     |                 | (6.3" x 5.0" pipe-arch)                          |  |
|   | 13           | LVERI         | DES                              | CULVERT DESCRIPTION           | TON          |                  |         |               |           |                            |            | =          | HEADWATER    | TER  | COMP                 | COMPUTATION | N O    |                           |                  |                 | $\vdash$   |  |
| <u></u>   | ᄔ            | <u> </u>      | 1                                |                               |              |                  |         |               | IKEL      | COXTROL                    |            |            |              | 늘  | COKTROL HW. HITO-LSO | Ψ¥          | H 18   | .L.S.                     | П                |                 |  |  |
| 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2   | KIT33LOR4    | 0383TIM       | (AUTDUATE<br>3TA.M<br>(esestive) | VERTICAL                      | SASTIM       | TOS\$ -QKZ       | 5 1 2 E | <b>.</b>      | 취         | HW                         | *          | Ξ          | ţ            | £ 40   | ΥL                   | 2           | . 68.1 | H.W.                      | nut.             | TASELING.       | UTLET<br>TEOCITY                                 | COMMENTS   |
| Ka Cartikind - 0.2  | 2            | 5             | -                                | 33                            | 5            | 5                | ٥       |               |           |                            |            |            |              |  | ۰                    | •           |        | •                         |                  | $\overline{}$   | · ·  |  |
| 6.3'x 5.3'  | •            | _×            |                                  |                               |              |                  | 5       | 45            | 0.45      | 2.3                        | 0.7        | 0.5        | 1.6          | 3.3  | 1.9                  | 3,3         | 1.8    | 2.0                       | 04.              | 2.3             | 4.5  | Based upon TW  |
|   | >            | _×_           |                                  |                               |              |                  | . 22    | 197           | 0.75      | 3.8                        | 0.7        | 1.8        | 2.7          | 3.9  | 3.0                  | 3.9         | 1.8    | 3.9                       | 8                | 3.9             | 7.1  | Based upon TW  |
| 48" reller 19   | p1년<br>-     |               |                                  |                               |              |                  |         |               |           |                            |            |            |              |  |                      |             |        |                           |                  |                 |  | -  |
|   |              |               |                                  |                               |              |                  |         |               |           |                            |            |            |              |  |                      |             |        |                           |                  |                 |  |  |
|   |              |               |                                  |                               |              |                  |         |               |           |                            |            |            |              |  |                      |             |        | -                         |                  | +               | <del>                                     </del> |  |
|   |              |               |                                  |                               |              |                  |         |               |           |                            |            |            |              |  |                      |             |        |                           | ,                |                 | -  |  |
| sublant and reconnendations<br>For Q2 = 45 cfs Vb =<br>For Q50 = 125 cfs Vb = | cfs<br>5 cfs | - FEE         | 55 S                             | Vb = 8.0 fps<br>Vb = 10.7 fps | fps<br>/ fps |                  |         | <del>88</del> | 1.3 ft. ( | (n = 0.024)<br>(n = 0.024) |            | d d        | e Gri        | for the culvert barrel<br>for the culvert barrel | rrej.                |             | 1      | 1                         | 1                | 1               |  |  |

O bit ergiete fingtifet fin bien toets . O porte be bemein, O be, it tit ginite et

Assume the 48" relief pipe would carry 75 cfs during a Q50. TW is based upon weir elevation and height of flow above weir less the pipe outlet elevation.

| 18.19.111                               |                                 |           |                    |   |                |            |         |              |                    |                 |                                       |                            |             |               |   |            |             |                     | ŀ    |           | -             | US BEFA          | US DEPARTMENT OF TAXMSPOATATION FEDERAL HIGHWAY ADMINISTRATION: |
|---|---------------------------------|-----------|--------------------|---|----------------|------------|---------|--------------|--------------------|-----------------|---------------------------------------|----------------------------|-------------|---------------|---|------------|-------------|---------------------|------|-----------|---------------|------------------|---|
|   |                                 |           | •                  | <del>-</del>  | C              |            | CULVERT | T<br>T       | _                  | DE              | DESIGN                                | Z:                         | (I)         | I E           | SHEET   | ,          |             |                     | •    |           | -             | ALGION 1         | EN YANCOLYEN, WASHINGTON  |
|   | ļ                               |           |                    |   | <b> .</b>      |            |         |              |                    | B-2             |                                       |                            |             |               |   |            |             |                     |      |           |               |                  | B-2   |
|   |                                 | ran i     | Lubidel   1271043  |   |                |            |         |              |                    | 104474          |                                       |                            | ,           | ļ·            | C. LYLLEW   | Ī          |             |                     | ļ    |           |               | l                | HITION  |
| 5                                       | Camp. Creek                     |           | 700                | ļ   |                |            |         |              |                    | 48.2            | 7                                     | -                          | Itamat best |               | · <u>-</u>  | Z. CINIKOK | Ţ           | ļ                   | \    |           |               |                  |   |
| ššín<br>—                               | USSS Quad - "Inhaha, Oregon"    | · [=]     | rhaha,             | \ <u>\\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\</u>     | _uot           |            |         |              |                    |                 |                                       |                            |             |               |   |            |             |                     |      |           |               | /                |   |
|   |                                 |           |                    | <b>;</b>  |                |            | 8       |              | +                  | !<br>∴ <u>≅</u> | £<br>₩                                |                            | •           | <del></del> - | <del>}</del>  | ]          | 1           | \                   |      |           |               |                  | ,   |
|   | -                               | 1014194   |                    |   |                |            | 11(1)   |              | Ē                  | Per I Har       | 744                                   | ֝<br>֭֭֡֡֜֜֝               | 441414      |               |   |            | V           | İ                   |      | j         |               |                  |   |
|   | •                               | į         | **********         |   |                |            |         |              |                    | 111             |                                       |                            |             | <u> </u>      |   |            | `           |                     | (    | }         | 1             |                  | <br> -<br> -  |
| <u> </u>                                | Br                              | Browning  |                    |   |                |            |         |              |                    | 11/8/88         | , , , , , , , , , , , , , , , , , , , |                            | .           | <br>          | 1072  | 2 1        |             |                     | 0240 | 0 07401/1 | بر<br>ج       |                  | 1   |
| 6                                       | 155                             | 153 cfs   | 11 45              |   |                | \$         |         |              |                    | 1.6'            |                                       |                            |             |               | 777   | J          | ž           | A<br>\$             |      |           | <u>}</u>      |                  | (nr. 1969.7   |
| <u> </u>                                | 615                             | 619 cfs   | ,,                 |   |                | 7          |         |              |                    | 3,3'            | !                                     |                            |             | •             |   |            |             |                     |      |           |               |                  |   |
|   |                                 | 3         |                    |   | 110            |            | -       |              |                    |                 |                                       |                            | =           | HEADWATER     | 1 4 4   | 1705       | COMPUTATION | 2                   |      |           |               |                  |   |
|   |                                 | WETAL     |                    | IPE PICADWALLS                                      | ADWAL          | Ц          | Ī       |              |                    |                 | AUTERI                                |                            |             |               | 11111   | I٦         |             | ;                   |      |           |               |                  |   |
|   | OH!                             | 9#4       |                    |   | 43             |            | \$12E   | <u> </u>     | <u> </u>           | וארניו<br>ביורי | 101                                   |                            |             |               | 1110  | -          |             | 11W - H 1 No - L 20 | 100  |           |               |                  |   |
| SIZE                                    | 1380HG0<br>3-3V00R8<br>1733LG#4 | TOBLOM    | ZASTIM<br>KUTOUATZ | (UTDURT)<br>3TA.M<br>(4343TM)<br>ADITRIV            | VERTICA        | END: 3 EC. | ,       |              |                    | 취o              | 3                                     | ν.                         | ×           | 4             | 4.40  | *          | 29          | L3,                 | ¥    | MA MA     | TROLLIN<br>WK | UTLET<br>ELOCITY | COMMENTS  |
| Ke Caelikias - 0.2                      | <del>i  </del>                  | 2         | 7.0                |   | 5.0            | -          | 2       | $\dashv$     | .                  |                 |                                       |                            |             |               |   | ٠          | ۰           |                     |      |           | ***           | is l             | ,   |
| 8' Dia. w/l' high baff es               |                                 | ē         | affle              | <u></u>   | 1              |            |         | <br>         |                    |                 |                                       |                            |             |               |   |            |             |                     |      | j         |               |                  |   |
| Equiv.                                  | 7-1/                            | 150.      | ×                  |   |                |            | 7.5     | 3 153        |                    | 9.0             | 4.5                                   | 0.7                        | 0.4         | 3.3           | 5.4   | 1.6        | 5.4         | 2.4                 | 3.4  | 0.45      | 4.5           | 8.4              | Barrel Velocity   |
| Equiv.                                  | 7-1/\$                          | -         | ×                  |   |                |            | 7.5     | 619          |                    | 2.0             | 15.0                                  | 0.7                        | 5.5         | 6.3           | 6.9   | 3.3        | 6.9         | 2.4                 | 10.0 | 1.3       | 15.0          | 13.8             | Barrel Velocity   |
|   |                                 |           |                    |   |                |            |         |              |                    |                 |                                       |                            |             |               |   |            |             | _                   |      |           | -             |                  |   |
|   |                                 |           |                    |   |                |            |         |              |                    |                 |                                       |                            |             |               |   |            |             |                     |      |           |               |                  |   |
|   |                                 |           | <u> </u>           | -   | <del>  -</del> | <u> </u>   |         | <u> </u>     | _                  |                 |                                       |                            |             |               |   |            |             | <u> </u>            |      |           |               |                  |   |
| SULHARY                                 | SUPPART AND RECOMMENDATIONS     | CONIN     | ENDATA             | , X   |                |            | ,       |              | ;                  |                 |                                       |                            | ] ;         |               |   |            |             | 1                   |      |           |               |                  |   |
| For Q2 = 153 cfs<br>  For Q50 = 619 cfs | ે 153 લ<br>= 619 c              | fs<br>:fs | > >                | $v_D = 8.4 \text{ fps}$<br>$v_D = 13.8 \text{ fps}$ | 3.4<br>3.8     | र्घ<br>इत् | ම ලා    | <del>9</del> | <del>0</del> = 3.2 | 5. f.f.         | n = 0<br>                             | 0<br>0<br>0<br>0<br>0<br>0 | for<br>Grad | e e           | 3.2 ft. $\{n = 0.040\}$ for the culvert barrel 7.5 ft. $\{n = 0.040\}$ for the culvert barrel | irrel.     |             |                     |      |           |               |                  |   |

E-12

Note: Baffles and sediment deposits reduce the barnel velocities due to increased roughness.

O 15 CATES PARTIE IN UNO PUG . O 181 IL 18 YEART .

| #14.07  | CULVERT                         | >             |          | . <del> </del>   | DE                 | DESIGN     | \ Z   | o                                      | T H              | SHEET  |            |       |                  |  |  | US BE<br>TEGER<br>ALSO | US BEPARTUENT OF TRANSPORTATION<br>FEDERAL, HISHWAY ADPRINTANTION?<br>REGION TEK VANCOVIER, WASHINGTON |
|---|---------------------------------|---------------|----------|------------------|--------------------|------------|-------|--|------------------|--|------------|-------|------------------|--|--|------------------------|--|
| 13)/07/   | = Y                             |               | . .      |                  | 5.3                |            | 1111  | . 11ma C P4 11                         | 1. 1             | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1                          | T' KIKIFUM |       |                  | .  |  |                        | 1414<br>1414   |
| USSS Ovad - "ETK MT.  | nobalo                          | 14            | 4        |                  | 8                  | 46£        |       | Месния                                 |                  | <del>}</del>   | :          | 1     |                  | -  |  |                        |  |
| Browning events or 25 cfs   |                                 | 7 2           |          |                  | 11/8/88            | 8          |       |  | 1   1            | 9,cc 3775,4  | 4.2        | 1 1   | 00               | 644-54- 0.0255'/, to 66.6                    | \ \ \(\frac{1}{2}\)                              |                        | 17.3773.7  |
| 9.14 116 cfs  |                                 | TW'E          |          |                  | 2.7                |            |       |  | <u> </u>         |  |            |       |                  |  |  |                        | •  |
| CULVERT   | DESCRIPTION                     | ! !           |          |                  | 13 13              | COXTROL    |       | \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ | HEADWATER<br>001 | =  | CONTROL    | 151   | RW H H Po - L So |  | -  |                        |  |
| S S S S S S S S S S S S S S S S S S S   | STRUCTURAL MATE MITERED MITERED | S END SECTION | 512E     | 0                |                    | ¥          | 2     | ×                                      | 4                |  | <b>* •</b> |       | . °81            | Will W                                       | CONTROLLING                                      | OUTLET<br>VELOCITY     | COMMENTS   |
| ×   |                                 |               | 5.4      | . 55             | .25                | 1.4        | 0.7   | 0.5                                    | 1.0              | 3.2  | 7          | 3.2   | 1.7 2.0          | 0.4  | 1 2.0  | 3.9                    | Based upon TW  |
| -   | <u> </u>                        |               | 5.4      | 116              | .65                | 3.5        | 0.7   | 0.8                                    | 2.2              | 3.8  | 2.7        | 3.8   | 1.7 2.9          | 9 0.5  | 3.5  | 5 6.1                  | Based upon TW  |
|   |                                 |               |          | ,                |                    |            |       |  |                  |  |            |       |                  | i  |  |                        |  |
|   |                                 |               |          |                  |                    |            |       |  |                  |  |            |       |                  | <u> </u>                                     | <u> </u>   |                        |  |
|   |                                 |               | <u> </u> |                  |                    |            |       |  |                  |  |            | -     |                  |  |  |                        |  |
|   |                                 |               |          |                  |                    |            |       |  |                  |  |            | 1     | <u> </u>         | <u>                                     </u> | <del>                                     </del> |                        |  |
| summary and reconnendations<br>For Q2 = 25 cfs  | Vb = 6.5 fps<br>Vb = 11.0 fps   | Ş             | <u> </u> | -8 <del>-8</del> | 0.8 ft.<br>1.6 ft. | = =<br>= = | 024)  | for<br>the                             | e e e            | 0.024) for the culvert barrel<br>0.024) for the culvert barrel | mel.       |       |                  |  |  |                        |  |
| Note: TW is based upon weir elevation and height of flow above weir less the pipe outlet elevation. | weir elevat                     | ion a         | nd he    | ight o           | fflowa             | bove w     | ir le | ss the                                 | pjpe             | outlet   | eleva      | tion. |                  |  |  |                        |  |

E-13

O 155 COULT PROTECT IN 1863 PRES CONT. S PARTIL O PO B 155 CHIEF H

| 1055 Qual - "Interior Creek   18.8   18.8   19.8    |  | \   \   \   \     \ |                | ן ני     |         | z                 | Ū  | L L  |  |  |          |  |  |  | US 007   | US OFFAILTER OF TRANSFORTSTON<br>FEDERAL MISSERTION:<br>REBON TEN YANCOVIES, WASHINGTON |
|--|--|---------------------|----------------|----------|---------|-------------------|--|--|--|--|----------|--|--|--|--|---|
| Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon"   Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregn - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypested, Oregon - "The Stand - "Hypes   | 000  | \                   |                |          |         | <u>7</u> .        | 5  | ֡֝֝֝֡֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֡֜֝֓֓֓֓֡֜֜֡֓֓֓֡֓֜֝֡֡֓֓֡֡֡֡֡֡֡֡ | -  |  |          |  |  |  | 1  |   |
| Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan"   Stand - "threstead, Overan   |  |                     |                | 9-0      |         |                   |  |  |  |  |          |  |  |  |  | D-8   |
| 1   2   2   2   2   2   2   2   2   2  | 17th 1271044   |                     |                | PARTIE   |         |                   |  | I ·  | £1 Cy 1719                                       |  |          |  | {  |  |  | 1 TATION  |
| Stand - "functional of the control   |  |                     |                | 18.8     | - 1     |                   | 10436 94                                     | -  | -  | MOMIN  |          |  |  |  |  |   |
|  | Mary many  |                     |                |          |         |                   |  |  |  | ļ  |          | <u> </u>   |  |  | /  |   |
| 142 cfs   1   1   1   1   1   1   1   1   1  | USS Quad - "Homestead, Uregon  |                     | }              |          |         |                   |  | _  |  |  |          |  |  |  | /  |   |
| 1/2 Cfs   1/2 Cfs   1/2   24   24   24   24   24   24   24   | •  | 33                  |                | 45       | 8       |                   |  | _  | <br> - <del> </del>  <br> -                      |  | 1        |  |  |  |  | _   |
| 1/2 Cfs   1/2    | 10(11)04   | 11(1)               | <u>:</u>       | 114.0    | FAIR    |                   | NT DIG 7 N                                   | 1  |  |  | 1        | İ  |  |  |  |   |
| 142 cfs   1 - 1 - 2   1 - 5    |  |                     |                |          |         |                   |  | _  |  |  | _        |  | 1 8  | 18   |  |   |
| 142 cfs   1 - 1 - 2     1 - 5  |  |                     |                | 31/8/8   | ~       |                   |  |  | _  |  | 1        |  |  | } }  |  |   |
| 142 cfs   15   15   15   15   15   15   15   1   | SYOMITING COLORES  |                     |                |          |         |                   |  | <u>ئ</u>   | 88   | 11   | 4.5      | 9  | 74.7   | 99.5   |  | 3000  |
| ### And a continue with the continue with the colorest barrel.  ### And a continue with the colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  ### And a colorest barrel.  #### And a colorest barrel.  #### And a colorest barrel.  ###################################  | 142 cfs  |                     |                | 1.5'     |         |                   |  | :<br>  |  | Sm ]]  | buld     | ors. c   | bbles.                                       | and c  | ravels   | within  |
| CONTROLL    |  |                     |                | 18 6     |         |                   |  | <u>.                                     </u>      |  | 1,00   | harr     | -  |  |  |  |   |
|  | 444 cfs  | 2                   |                | 4.4      |         |                   |  | 1  | 7  | 12617  | 3        |  |  |  |  |   |
| ### ##################################   | CULVERT DESCRIPTION  |                     | μ              |          |         |                   | HE   | DWAT   | 5  | COMPL  | TAT10    | _  |  |  |  |   |
| ### K, H 4, 4+0 TW 10 TW | BITAL PIPE MEADWALLS   |                     |                |          | 11101   |                   |  |  |  | ONTROL   | #.<br>#. | 1.00-1   |  |  | ļ  |   |
| 8.5' Open bottpm arch W3' of exposed footings.  18.0' x 11.5'  x  11.5   142   0.25   2.9   0.7   0.25   2.3   6.9   1.5   6.9   1.2   6.0   6.0   6.0    x  x  11.5   444   0.50   5.8   0.7   0.75   3.5   7.5   2.4   7.5   1.2   7.1   0.6   7.1   8.2    1.42 cfs   Wb = 5.8 fps   0   db = 2.4 ft. (n = 0.045) for the culvert barrel.  1.44 cfs   Wb = 8.2 fps   0   db = 4.3 ft. (n = 0.045) for the culvert barrel.   | MITERED  MITERED  STRUCTURA  PLATE  P | SIZE<br>D           |                |          | H W     | ×*                | I  |  | 2<br>7<br>7                                      | <b>≱</b> •   |          |  |  |  |  | COMMENTS  |
| 19.0' x 11.5'   x   11.5 142 '0.25   2.9   0.7 0.25   2.3 6.9   1.5 6.9 1.2 6.0   0.5 6.0 5.8   2.8   2.4 7.5 1.2 7.1   2.4 7.5 1.2 7.1   2.5 2.4 7.1   2.5 2.4 7.1   2.5 2.4 7.1   2.5 2.4 7.1   2.5 2.4 7.1   2.5 2.4 7.1  | Open bottom anch w/3   |                     | i .—           |          |         |                   |  |  |  | -  |          |  |  |  |  |   |
| X   11.5 142 '0.25 2.9   0.7 0.25 2.3 6.9 1.5 6.9 1.2 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 0.5 6.0 5.8   1.5 6.0 0.5 6.0 0.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.5   1.5 6.0 0.   | .0.<br>13  |                     |                |          |         |                   |  |  |  |  |          |  |  |  |  |   |
| X  X  11.5 444 0.50 5.8 0.7 0.75 3.5 7.5 2.4 7.5 1.2 7.1 0.6 7.1 8.2  WENDATIONS  WE S.2 fps 0 db = 2.4 ft. (n = 0.045) for the culvert barrel.  Wh = 5.8 fps 0 db = 4.3 ft. (n = 0.045) for the culvert barrel.  Wh = 8.2 fps 0 db = 4.3 ft. (n = 0.045) for the culvert barrel.  Wh = 8.2 fps 0 db = 4.3 ft. (n = 0.045) for the culvert barrel.   |  | 11.5 14             |                |          | 6.3     | 0.7               | .25  |  | 6.9  |  |          |  |  |  |  | Barrel Velocity   |
| wendations  Wb = 5.8 fps   | ×  | 11.5                | i –            |          | 8.3     | 1                 | .75  |  | 7.5  | <del>i                                      </del> | -        | <del>}                                    </del> | <del> </del>                                 | <del>                                     </del> | <del>.                                    </del> | Barrel Velocity   |
| WENDATIONS  WD = 5.8 fps   |  |                     |                |          |         | <u> </u>          | <u>                                     </u> |  |  |  |          | 1  | <u>                                     </u> | <u> </u>   |  |   |
| Wb = 5.8 fps   |  |                     |                |          |         | 1                 | -  |  | <del>                                     </del> |  |          | -  | -  |  |  |   |
| Vb = 5.8 fps   | SUMMARY AND RECOMMENDATIONS  |                     | -              |          |         |                   | 1  | 1  |  |  | 1        | -  |  | }  |  |   |
| Che Cital Blast old B  |  |                     | b = 2.65 = 4.5 | 1 ff. (  | n = 0.0 | 245) <del>(</del> | for the                                      | ਨੂੰ<br>ਨੂੰ   | it<br>Egit                                       | بارة<br>بوا.                                       |          |  |  |  |  |   |
| Conferin is parette, O be is   |  |                     |                |          |         |                   |  |  |  |  |          |  |  |  |  |   |
|  | -  |                     | 2.5            | נומנו נו |         |                   |  | ٠.   |  |  |          |  |  |  |  |   |

| 7111   | CU   | CULVERT                           | H. H.   | -                                       | DE                 | DESIGN             | Z          | ၂ တ            | 日日        | SHEET  | .          |             |             |             | : -                     | 500                | US DEFABLIENT OF INASPONIATION PEDENLE, HIGHWAY ACHMINIANION'S ALAKKE WASHINGTON |
|--|--|-----------------------------------|---------|---|--------------------|--------------------|------------|----------------|-----------|--|------------|-------------|-------------|-------------|-------------------------|--------------------|--|
|  |  |                                   |         |   | 15-0               |                    |            |                |           |  |            |             |             |             |                         |                    | 15-0   |
| Elk Creek  |  |                                   |         | ·                                       | 25.5               |                    |            | 10 met 10 mets | · \$      | 1, KI  | 2 KINIKUM  |             |             |             |                         |                    | BEATION  |
| <u> </u>   | "Elk Mtn., Oregon"   |                                   |         |   |                    | 78 74 6            |            |                |           |  |            |             |             |             |                         | /                  |  |
|  | 1  | 33                                |         | <u> </u>                                | ī                  | 45€                |            | . '            |           | — <del>}</del> _                                   |            |             |             |             |                         |                    |  |
| ₩17341   |  | 911                               | 1161944 | Ţ.                                      | 700401             | FINE               | 2          | PENHAR         | ļ         |  |            | 1           |             |             | j                       |                    |  |
| Browning   |  |                                   |         |   | 11/8/88            | <br>  &            |            |                | 1         |  |            |             |             | {           | }                       |                    | <u> </u>   |
|  | r  |                                   |         |   | 1.0                |                    |            |                | <u></u>   | na 2013.2  | 75.        | Creds-50*   |             | 7.010       | 0.010'.L' to 60':       |                    | 10 607.  |
| וֹ וֹ  |  | <br>                              |         |   | 2.2'               |                    |            |                | <u> </u>  | parrel.  | [a]        |             |             | t and the   |                         | מאס וו             |  |
| CULVERT  | T DESCRIPTION  |                                   |         |   |                    |                    |            | , E            | HEADWATER | ER   | COMP       | COMPUTATION |             | .           |                         |                    |  |
| 11   | PIPE PEASOWALES  | NO                                |         |   | INLET C            | COXTAGE            | Ц          |                |           | 틸  | COXIXOL    | HW+H4%      | + ho - L So | اي          |                         |                    |  |
| S S S S S S S S S S S S S S S S S S S                                      | TANGUETURA<br>TANG<br>(DISTING)<br>JADITATY CO<br>CIRSTIN CO | END- \$5071                       | 0 0     |   | ,                  | 16.94              | ā.         | <b>=</b>       | ¥         | 440  | <b>≱</b> 6 | 2 •         | . °S1       | 111111 W HW | בוצה בואס<br>אא אטרבואם | OUTLET<br>VELOCITY | COMMENTS   |
| <u>  &gt; ~  </u>  | extrasec   | footings                          |         | -                                       |                    | -                  |            |                |           |  |            |             |             |             |                         | ,                  |  |
|  | ×  |                                   | 7.1     | 71                                      | .25                | 1.8                | 0.7        | .2             | 1.4       | 4.3  | 1.0        | 4.3 0       | 0.6 3.9     |             | 0.5                     | 3.9 3.9            | Barrel Velocity  |
|  | ×  |                                   | 7.1     | 333                                     | 7                  | 5.0                | 0.7        | 1.0            | 2.8       | 5.0  | 2.2        | 5.0 0.2     | 0.6 5.4     |             | 0.8 5                   | 5.4 6.0            | Barrel Velocity  |
|  |  |                                   |         |   |                    |                    |            |                |           |  |            |             |             |             | -                       | · · ·              |  |
|  |  |                                   |         |   |                    |                    |            |                |           |  |            | <u> </u>    |             |             |                         | •                  |  |
|  |  |                                   |         |   |                    |                    |            |                |           |  |            |             |             | ·           |                         |                    |  |
| For 02 = 71 cfs Vb = For 050 = 333 cfs Vb =                                | Vb = 3.9 fps<br>Vb = 6.0 fps                                 |                                   | 6.6     | ⊕<br>⊕<br>= 4                           | 1.8 ft.<br>4.3 ft. | (n = 0.<br>(n = 0. | = 0.045) 1 | for th         | e culv    | for the culvert barrel.<br>for the culvert barrel. | mel.       |             | -           | }           |                         |                    |  |
|  |  |                                   |         |   |                    |                    |            | -              | ,         |  |            |             |             |             |                         |                    | -  |
| O 151 (wester purefice sta home forts but and and persons for alter states | -  | OTAL IS DUSTE.<br>LINE CITES HELE | 1       | 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 | 0 % 6 11 catation  |                    |            |                |           |  |            |             |             |             | 1.                      |                    |  |

| State   Color   Colo   | /4.00-134<br>[Ast 4-12]  | .             |                |                |                 |        |       |             |              |              |              |          |            | 1    |             | 12 00.             | ATMENT OF TRANSPORTATION |  |
|--|--|---------------|----------------|----------------|-----------------|--------|-------|-------------|--------------|--------------|--------------|----------|------------|------|-------------|--------------------|--------------------------|--|
| State   Control   Contro   |  |               | 日兄             | <b> -</b>      | 口匠              | SIC    | Z.    | ഗ           | Ш<br>Ш       | E            |              |          |            |      |             | 1000               | CH VANCONER, WASHINGTON  |  |
| State   Control of the control of    |  |               |                |                | 15-€            |        |       |             |              |              |              |          |            |      |             |                    |                          |  |
| Street   Control   Contr   | ]mg/m_131/6#4  |               |                |                |                 |        |       |             | <u> </u>     | C. Lvarion   | j            |          |            |      |             | Į.                 | \$TATION.                |  |
| Street   Control   Contr   | Chesnimus Creek  |               |                |                | 25.5            | - 1    |       | 4 227       | ş            | <u>∓</u>     | KINGK        |          | \          |      |             | /                  |                          |  |
| Browning   11/20/20    |  |               |                |                |                 |        |       |             |              |              |              |          |            |      |             | /                  |                          |  |
| Broating   Broating   11/9/98   Broating   11/9/98   Broating      |  | . 2           |                | •              | **              | 47F    |       |             |              | - <u>*</u>   |              | \        |            |      |             |                    |                          |  |
| State   Stat   | P4117781   |               | C1 10 4        | -              |                 |        |       | BY BUILDING | <u> </u>     |              |              | 1        |            |      |             |                    |                          |  |
| ### 155   157   15 | #1#f15114  |               |                |                | 11,707          | 1      |       |             |              | _            | 1            |          | ,<br> <br> | }    | 1           |                    | 1                        |  |
| 38  cfs   1.5°   1.5°   2.9°   |  |               |                |                | 2/1             | 8      | ŀ     |             | -<br>-       | - 1          | 4.           |          | 8          |      | 49.7        |                    |                          |  |
| State   Court   Cour   | 91 cfs   | 1,6,41        | ١              |                | 1.5             |        |       |             |              | C. C.        | ,<br>obbles  | oray     | al, and    | some | small       | boulde             | ענני                     |  |
|  |  | 1. ## · I     |                |                | 2.9'            |        |       |             | 1            | with         | in the       | culve    | t barr     | [a]  |             | ,                  | •                        |  |
|  | CULVERT DESCRIPTI  | OH            |                |                |                 |        |       | 7           | ADWATE       |              | UNIO         | ATION    |            |      |             |                    |                          |  |
| 5.1. X   10.0   1. | FCTAL.   | ľ             |                |                |                 | OKTROL |       |             | •            | 5            | i I          | H. H.    | ام-ا-م     |      | L           |                    |                          |  |
| 5.1' X X 6.5 1.1 6.3 0.7 2.7 4.0 4.8 2.9 4.8 0 7.5 1.3 7.5 7.6 Barrel 5.1' X 7 8 1.8 1.1 6.3 0.7 2.7 4.0 4.8 2.9 4.8 0 7.5 1.3 7.5 7.6 Barrel 7.1  | CONCRETE PROJECTINE CONCRETE C |               | 312E           | o .            |                 | ¥      | ×     | ±           |              |              | , –          | , s      | ¥.         | # HW | CONTROLLING | OUTLET<br>YELOCITY | COUNENTS                 |  |
| 5.1' X   X   5.7 381 1.1   6.3   0.7   2.7   4.0   4.8   0   7.5   1.3   7.5   7.6   Barrel    NY - AND NECOMMENDATIONS  | x 5.71   |               | 5.7            | 16             | 0.4             | 2.3    | 0.7   | 0.5         | <del> </del> |              | .5           | 4        | 3.9        | 0.7  | 3.9         | 1.8                |                          |  |
| NY AND MECONUENDATIONS  NY AND MECONUENDATIONS  1 = 91 cfs  Vb = 7.6 fps  0 db = 5.7 ft. (n = 0.04)  0 and 1 = 5.7 ft. (n = 0.04)  Barrel velocity in this case = arch area = 50 ft. 2  Hitt Hantia M 1 M 1 PM 1 PM 1 PM 1 PM 1 PM 1 PM 1  | x 5.7'   |               |                |                | 1.1             | 6.3    | 0.7   | 2.7         |              | <del> </del> |              |          | 7.5        | 1.3  | 7.5         | 7.6                |                          |  |
| NY - A KD DECOMMENDATIONS  1 = 91 cfs  1 = 91 cfs  1 = 91 cfs  1 = 91 cfs  1 = 91 cfs  1 = 91 cfs  2 = 5.7 ft. (n = 0.04)  4 0  Barrel velocity in this case = arch area = 50 ft. 2  1111 HABITIA M IMILIARIE CHAINS HABITIA IN THE RESIDENT OF SECTION OF SE |  |               |                | , -            |                 |        |       |             |              |              |              |          |            |      |             |                    |                          |  |
| NY AND MECDIALENDATIONS  1 = 91 cfs  2 = 91 cfs  4 = 5.7 ft. (n = 0.04)  6 = 5.7 ft. (n = 0.04)  9 0  Barrel velocity in this case = arch area = 30 ft.2  THE HABITALM HALL OF STREET IN THE STREET IN THE CHARACTERS OF STREET IN |  |               |                |                |                 |        |       |             |              |              |              |          |            |      |             |                    |                          |  |
| NY AND MECONMENDATIONS  = 91 cfs  Vb = 1.8 fps  0 db = 5.7 ft. (n = 0.04)  0 = 381 cfs  Vb = 7.6 fps  0 db = 5.7 ft. (n = 0.04)  Barrel velocity in this case = arch area = 50 ft. 2  HIRTORIGATION INCLUSION OF STREET IN THE STR |  |               |                |                |                 |        | •     |             |              |              |              |          | ···-       |      |             | -                  |                          |  |
| NY AND MECONMENDATIONS $= 91 \text{ cfs} \qquad \text{Vb} = 1.8 \text{ fps} \qquad 0 \text{ db} = 5.7 \text{ ft. } (n = 0.04)$ $0 = 381 \text{ cfs} \qquad \text{Vb} = 7.6 \text{ fps} \qquad 0 \text{ db} = 5.7 \text{ ft. } (n = 0.04)$ $0 \qquad 0 \qquad 0 \qquad 0$ Barrel velocity in this case = arch area = $50 \text{ ft.} 2$   |  |               | •              |                |                 |        |       | <u> </u>    |              | <br>  <br>   | <u> </u>     | <u> </u> |            |      |             |                    | ,                        |  |
| this case = arch area = erch a | HENDA  | ي<br>ية<br>ية | <del>8</del> € |                | ) ئۇرۇ<br>ئۇرۇپ | 0.04   | for t | he cu'      | vert b       | amel.        | <del> </del> | -        | _          |      | ]           |                    |                          |  |
| ORAL II K DUNEL O De G   |  |               | ch arre        | ii<br>E        | tt 2            |        |       |             |              |              |              |          |            |      |             |                    |                          |  |
| the climation of the teat  | ]  |               |                |                |                 | İ      |       |             | ٠.           |              |              |          |            |      | İ           |                    |                          |  |
|  |  |               |                | 25<br>25<br>25 |                 |        |       |             |              |              |              |          |            |      | ٠           |                    |                          |  |

| [4.8-1]4<br>[4. 1-1]   |   |             |   |          |   |  | <br> <br>   |                                 |                 |                                |                  |             |            |          |     |                   | VS OCFAN   | US OFFARINGET OF TRANSPORTATION PROCESS. MICHAL MICHAL ADMINISTRATION. |
|--|---|-------------|---|----------|---|--|-------------|---------------------------------|-----------------|--------------------------------|------------------|-------------|------------|----------|-----|-------------------|------------|--|
| :  |   | O           | CULVERT                                       | /E       | RT  | OE   | DESIGN      | Z.                              | ഗ               | SHEET                          | -<br> <br>       |             |            |          |     |                   | AC 6104 TC | и уансолуев, жазнінетож  |
|  |   |             |   |          |   | 15-F   |             |                                 |                 |                                |                  |             |            |          |     |                   |            | 15-F   |
| Crow Creek   | 1=Y4 121four  |             |   |          |   | 55.8   | ·<br>•      |                                 | .               | <u> </u>                       | E, KIN           | E' KIRIKUM  |            |          |     |                   | ١          | - ALATION  |
| .  | PERCE BANK  |             | =   | -        |   |  | P44(4464 6A | 1111                            |                 |                                |                  |             |            | \        |     |                   | /          |  |
| · [.`  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1                     | 5           | 1   | 155<br>1 |   | ī  | 45E         |                                 |                 | <u></u>                        | — <u>*</u>       |             | 1          |          |     |                   | /          |  |
| *******  |   |             |   | 1010     |   | . levaine  | JHY1        | اِ                              | ed milyan       | T                              |                  |             | 1          |          |     |                   | _          | -  |
| Browning   | ning  |             |   |          |   | 11/8/88  | [<br>.88    |                                 |                 | 1                              | 3,7              |             |            | (   0    | }   | , 6               |            | <u> </u>   |
| 9.9  |   |             | , p   |          |   | 3.0'   |             |                                 |                 | []<br>                         | ္ပါ              | બ!.<br>`    | ¥-¥3       | 200      | -   | Ŕ                 | ]          | nr. 264.6  |
|  |   | .           | 7 1   |          |   | 5.2'   |             |                                 |                 | <u> </u>                       | NC#44KB.         |             |            |          |     |                   |            |  |
| יחי  | ERT DES   | DESCRIPTION | HOI   |          | -   |  |             |                                 | HE              | HEADWATER                      |                  | COMPUTATION | ATION      |          |     |                   |            |  |
|  | ]<br> -<br> -<br> -                                       | Ç.          |   |          |   | IKET   | CONTROL     | L.                              |                 | 0                              | =                | CONTROL     | HW. Ktho   | 1. S     |     |                   |            |  |
| 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  | MTD3LORY C.  O3R3TIN C.  ANUTOURTZ C.  STA.M C.  STA.M C. | S VERTICAL  | MITERED STEED                                 | 312      | a ,   | No.  | нж          | ₹.                              | π               | 4                              | £ +0 1           | <b>≥</b> •  | ه م<br>دي. | *        | HW. | CONTROLLING<br>HW | VELDCITY   | COMMENTS   |
| 12.8' x 5.0'   | ×   |             |   | 5        | 135   | 0.5  | 2.5         | 0.7                             | 0.5             | 1.5 3                          | 3.3              | 3.0 3.      | 3 0.7      | 3.1      | 9.0 | 3.1               | 3.9        | Based upon TM  |
| 12.8' x 5.0'   | ×   |             | <b></b>                                       | . 2      | 8   | 1.65   | 8.3         | 0.7                             | 0.9             | 3.7 4                          | 4.4              | 5.2 5.2     | 2 0.7      | 7 10.5   | 2.1 | 10.5              | 10.2       | Full Barrel Flow   |
|  | · · · · · ·   |             |   |          |   |  |             |                                 |                 | !<br>  <u>-</u>                |                  |             |            |          |     |                   |            | •  |
|  |   |             |   |          | <u> </u>  |  |             |                                 |                 |                                | -                |             |            | <br>     |     |                   |            |  |
|  |   |             |   |          |   |  |             |                                 |                 | ·                              | -                |             |            | <u> </u> |     |                   |            |  |
|  |   |             |   |          | <u> </u>  |  |             |                                 |                 | -                              | <del> </del><br> |             |            |          |     |                   |            |  |
| SUMMARY AND RECOMMENDATIONS<br>FOR Q2 = 135 cfs Vb =<br>For Q50 = 508 cfs Vb = | ENDATIONS<br>Yb = Vb = Vb = Vb = Vb = Vb = Vb = Vb =      | 5.4         | тюн <b>s</b><br>Vb = 5.4 fps<br>Vb = 10.2 fps | ୍ ଚ      | <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> <del>+</del> | 2.3 ft. (n = 0.040) for the culvert barrel 5 ft. (n = 0.040) for the culvert barrel. | (n = 0.09)  | 986<br>6 (5)                    | or the          | culve                          | rt ban<br>barrel |             | -          | 1        |     |                   |            |  |
| Assume the 48" relief pipe would carry 95 cfs during                           | ef pipe   | wonjc       | d carry                                       | 95 cf    | 's dum'i  | ng a (550.   |             | For Q50, $Vb = Q50$<br>Barrel X | = 050<br>K fami | Vb = Q50<br>Barrel X-Sect Area | Area             |             |            |          |     |                   | -          |  |
| O 15f Curtiff Ducezer led behad fields bif list bufasiir file leta geteffits   | entins .  | 910<br>171  | orei ir a juuri.<br>Liki capa kar             | TO THE   | 277   | 111 pt pt 111 16   | <u>_</u>    |                                 |                 |                                |                  |             |            |          |     |                   |            |  |
|  |   |             | •   |          |   |  |             |                                 |                 |                                |                  |             |            |          |     |                   |            |  |

| Ph 36-114<br>  (Av. 1-11   |                      |                      |                   |   | ,   |                  |             |                 |                    |               |                 |             |               |                | 5              | US DEPARTMENT OF TAXASFORTATION              |
|--|----------------------|----------------------|-------------------|---|---|------------------|-------------|-----------------|--------------------|---------------|-----------------|-------------|---------------|----------------|----------------|--|
| <b>O</b>   | CULVERT              | EF                   | 7                 | DE                                      | DESIGN  | Z                | ഗ           | П<br>П          | SHEET              |               |                 |             |               |                | MEGIC          | IEM VANCOURE, WASHINGTON                     |
|  |                      |                      |                   | 13-A                                    | <br>  |                  |             |                 |                    |               |                 |             |               |                |                | 12.A   |
|  |                      |                      |                   | W) O M P ( V                            |   |                  | ·           | j ·             | EL EVITION         | Ţ             |                 |             |               |                | ,              | STATION                                      |
| Meachan Creek - No. 1  |                      |                      |                   | 16.2                                    | ***************************************                                   |                  | State sette | ş               |                    | I MIKIKOK     |                 |             |               |                |                |  |
| USSS Quad - "Meacham, Oregon"  | "no                  |                      |                   |   |   |                  |             |                 |                    |               |                 | \           |               |                | /              |  |
| 7  | (*)                  |                      | 1                 | . 2                                     | 35  |                  | _           |                 | <u>*</u> -         |               |                 |             |               | •              |                |  |
| B01(12)87  |                      | 1011310              | ,                 | Touchair                                | 1)tre   | _                | MERIPARA    | <u> </u>        |                    |               | 1               |             | ļ             |                |                |  |
| DESCRIPTION OF THE PROPERTY OF |                      |                      |                   | 28/8/11                                 | 8   |                  |             | 1               |                    | ]             | j               |             | {             | {              |                | 1  |
| DITUMUITO  |                      |                      |                   | 70/1                                    | 3   |                  |             | ا <u>ج</u><br>ا | Arx 3657.7         | 7             | C. 45.7         | C. 0. 0.013 | 13. /         | /              |                | ۔ ا  |
| o.2 75 cfs   | 142                  |                      |                   | 1.6                                     |   |                  |             | <u> </u>        | REWAPKS.           | Sna11         | blucd           | ers. c      | ravels        | and.           | cobble         | Small boulders, gravels, and cobbles located |
| ••• 500 cfs  | · #                  |                      |                   | 4.5'                                    |   |                  |             | - I<br>         | with               | within barrel | mel             |             |               |                |                |  |
| CULVERT DESCRIPTION  | FION                 |                      |                   |   |   |                  | KE          | HEADWATER       | ER                 | COMP          | COMPUTATION     | _           |               |                |                |  |
| מונגור   | <u> </u>             |                      |                   | ואנצו כ                                 | CONTROL   |                  |             |                 | 131                | CONTROL       | CONTROL HW-HILD | 14 ho - LSa | ٠             | -              |                |  |
| MITERED MITERED MITERED MITERED MITERED MITERED MITERED  | MITERED              | 5 2 Z E              | σ.                | d<br>MJI                                | ¥   | ×.*              | =           | 4,              | <del>\$</del>      | *             | د ج             | <u> </u>    |               | ##<br>#05511HG | 131T<br>T1:20. | COMMENTS                                     |
| - 0.2 0.9 0.7 0.7  | 1.0                  |                      |                   |   |   |                  |             |                 | 1                  | •             | 0               | -           |               | -              |                |  |
| 14' x 12.8' set approximately 2  | 2 below the existing | <del>Je</del><br>exi | sting             | stream                                  | æd.   |                  |             |                 |                    | •             |                 |             |               | <del></del>    |                |  |
| Equivalent 10,8' mise by 12,8'   |                      |                      | -                 | -                                       |   |                  |             |                 |                    |               |                 |             |               | <u> </u>       |                |  |
| ×  |                      | 10.8                 | 75                | 0.2                                     | 2.2   | 0.7              | 0.5         | 1.1             | 6.0                | 1.6           | 6.0 11.         | 6.4.9       | 9 0.5         | 4,             | 9 4.8          | Barrel Velocity                              |
|  |                      | _                    |                   |   |   |                  |             |                 | 丁                  |               |                 | i i         | 1             | <del>-  </del> | _              |  |
| ×  |                      | 10.8                 | 33                | 0.5                                     | 5.4   | 0.7              | .75         | 3.2 7           | 7.0                | 4.5           | 7.0 1.          | 1.6 6.2     | 0.6           | 6.2            | 7.6            | Barrel Velocity                              |
|  |                      |                      |                   |   | _   |                  |             |                 |                    |               |                 |             |               |                |                |  |
|  |                      |                      |                   |   |   |                  |             |                 |                    |               |                 |             | · .           | İ              |                |  |
| SUMMARY AND RECORDENDATIONS  |                      |                      |                   |   |   |                  |             |                 |                    | <b> </b>      |                 |             | $\frac{1}{2}$ | -              |                |  |
| For $Q2 = 75$ cfs ib = 4.8 fps<br>For $Q50 = 375$ cfs ib = 7.6 fps   | 3 fps<br>5 fps       | ବ୍ର                  | db = 2<br>db: = 4 | 2.2 ft. (<br>4.9 ft. (                  | (n = 0.045) for the culvert barrel. $(n = 0.045)$ for the culvert barrel. | 245) f<br>245) f | or the      | culve<br>culve  | ert bar<br>ert bar | rel.          |                 |             |               |                |                |  |
| Assume the 10'x 8.8' (equiv. 9' $ ot\!\!/ ota$ ) pipe would car  | 9' g) pipx           | s would              | ı carry           | ry 125 cfs during 050.                  | ; durin   | g (50.           |             |                 |                    |               |                 |             |               |                |                |  |
| O 151 teritii mattiti m mai tuti o   | OTHER IS BURER.      |                      | 20                | 111111111111111111111111111111111111111 |   |                  |             | ·-              |                    |               |                 |             |               |                |                |  |
|  | Of HEAT BOTH         | •                    | -<br>-<br>-<br>-  | हिंदी में।                              |   |                  |             |                 |                    |               |                 |             |               |                |                |  |

| CUL                      | CULVERT  | T.Y                                   | 0 6                | DESIGN      | NS       | Ø         | T H              | SHEET                                    |                  |                |                   |          |               | 75 PC<br>75 PC<br>75 PC<br>75 PC | US PEFACTURED OF TRANSPORTATION FUR EACH TRANSPORTATION RESEARCH TEM YAMCOMER, WASHINGTON |
|--------------------------|--|---------------------------------------|--------------------|-------------|----------|-----------|------------------|--|------------------|----------------|-------------------|----------|---------------|----------------------------------|---|
|                          |  |                                       | 13-B               |             |          |           |                  |  |                  |                |                   |          |               |                                  | 13-18   |
|                          | ·<br> -  |                                       | 22.2               |             |          |           |                  | 1. 10                                    | MOMINIA .2       |                |                   |          | Ì             |                                  | . STATION   |
| "noosed "Meacham Orecon" |  |                                       |                    | rite Manage | 1 .      |           |                  | <u> </u>                                 |                  |                |                   |          |               | /                                |   |
|                          | . <del>Z</del>                                     |                                       | ≥                  | <br>  55    |          |           | <u> </u>         | ¥  |                  |                | \                 |          | •             |                                  |   |
| -                        | 11031  |                                       | Ternine.           | Spare       | 7        | W 2011 24 |                  |  |                  | 1              |                   |          |               |                                  |   |
|                          |  |                                       | 11/9/88            | 8           |          |           | 1                |  |                  | 1              |                   | { }      | {             |                                  |   |
| ;                        |  |                                       | 1.6                | 3           |          |           | <u> </u>         | nr 3640.4                                | ) <del>1</del> 2 | - <del> </del> | ्व<br>•           | 0.013'/' |               |                                  | ne. 3638.5  |
| :                        |  |                                       | 4.1.               |             |          |           | <u>-</u><br>     | within barrel.                           | Jan T            | <u>-</u><br> - | ers. g            | ave Is.  | y<br>Dua<br>P | Sel dao                          | nevans, Small bouiders, gravels, and comples located within barrel.                       |
| 10179                    | -  |                                       |                    |             |          |           |                  |  |                  |                |                   |          |               |                                  |   |
| PC PCAGWALLS             |  |                                       | IK(ET (            | CONTROL     |          | Ĩ         | HEADWATER<br>OUT | OUTLET                                   | CONTROL          | COMPUTATION    | H 16 - LS         | ٠        | $\vdash$      |                                  |   |
| CSASTIN C.               | 0.5 PER 0  |                                       |                    | нж          | <b>3</b> | =         | 4                | 440                                      | <b>≥</b> •       | . –            | LS <sub>0</sub> . | HW.      | E             | OUTLET                           | COMMENTS  |
| selov the                | existing stream bed                                | stream                                | ا bed.             | -           |          |           |                  |  |                  |                |                   |          | _             |                                  |   |
| r<br>S                   | -  |                                       |                    |             |          |           | -                | -  |                  |                |                   |          | ;             |                                  |   |
|                          | 13   | 8                                     | 0.2                | 5.6         | 0.7      | 0.2       | 1.3              | 7.2                                      | 1.6              | 7.2            | 1.9 5.5           | 5 .4     | 5.5           | 5.2                              | Barrel Velocity   |
|                          | 13   | 625                                   | 0.5                | 6.5         | 0.7      | 0.75      | 3.3              | 8.2                                      | 4.1              | 8.2            | 1.9 7.1           | 9.       | 7.            | 8.0                              | Barnel Velocity   |
|                          |  |                                       |                    |             |          |           | ,                |  |                  |                |                   |          |               |                                  |   |
|                          |  |                                       |                    |             |          |           |                  |  |                  |                |                   | ·<br>    | <u> </u>      |                                  |   |
| 5.2 fps<br>8.0 fps       | . ବ୍ର  | <del>8</del>                          | 2.4 ft.<br>5.3 ft. | <u>:</u> :  | 0.045)   | for       | he cul           | the culvert barrel<br>the culvert barrel | arrel.           | 1              |                   | -        |               | <u> </u>                         |   |
| ry 125                   | Assume the 10'\$ pipe would carry 125 cfs during a |                                       | .050               |             |          |           |                  |  |                  |                |                   |          | •             |                                  |   |
| CINT IF B PERSON.        | **************************************             | 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | וון נג<br>ווו נג   | 2           |          |           | •                |  |                  |                |                   |          | -             |                                  |   |
|                          |  |                                       |                    |             |          | ,         |                  |  |                  |                |                   |          |               |                                  |   |

E-19

| #8 19-134<br> 8  |                                 | С        | Uι            | _V             | EF          | ·<br>RT | DE                  | SIC          | ξŅ       | s        | HE             | EET         | -          |                |                   |          |                    |                    | PEDERAL            | RIMENT OF TRANSPORTATION HIGHWAY ROMBISTRATION: (EN VANCOUVER, MASHINGTON |
|--|---------------------------------|----------|---------------|----------------|-------------|---------|---------------------|--------------|----------|----------|----------------|-------------|------------|----------------|-------------------|----------|--------------------|--------------------|--------------------|---|
|  | ,<br>#AW [                      |          |               |                | <u>.</u>    |         | 13-C                | 4 .          |          |          | <del>-</del> - | ĘLIVAT      | <b>   </b> |                |                   |          |                    |                    | -                  | 13-C<br>BTATION   |
| Meacham Creek  | W 84WE                          |          |               |                | <del></del> |         | 22.3                |              |          | 10 MAR 1 | m.11           | Z'          | MINIMUM    |                |                   |          |                    | 1                  |                    |   |
| USGS Quad - "Mear  |                                 | Orego    | n"            |                |             |         | ,                   | •            |          |          |                |             |            |                |                   |          |                    |                    |                    |   |
|  | N AP                            |          |               | 35             | :           | _       | IN                  | 35E          |          |          | _              | AH)W • _    |            |                |                   |          |                    |                    | /                  | _   |
| LECATION   |                                 |          |               |                | L FJOH      |         | 1000250             | AAR          | ić       | #C#1014# | <u> </u>       |             |            |                |                   |          |                    |                    |                    |   |
|  |                                 |          |               |                |             |         | 4411                | ı            |          |          | -              | j           |            | Ι.             |                   |          | $\overline{\sim}$  |                    |                    |   |
| Browning   |                                 |          |               |                |             |         | 11/9                | /88          |          |          | _              | are 3733    | 3.7        |                |                   | 0.020    | 7.0.               | 135'               |                    |   |
|  | P4                              |          | •             | <b>-</b>       |             |         | 1.4'                |              |          |          |                |             | ,          |                |                   |          |                    |                    | hles               | located 3731.0  |
| °°2 — 95 cfs   | -                               |          | '             | <u>. 5</u> -   |             |         |                     |              |          |          | _              | •           |            |                |                   | <u> </u> | 215 <sub>1</sub> 0 | io coi             | <i></i>            |   |
| 9-10 625 cfs   |                                 | <u>.</u> |               | <b>*·</b> •• _ |             |         | 3.8'                |              |          |          | <u>-L</u>      | _with       |            |                |                   |          |                    |                    |                    | <u> </u>  |
| CULVE!   | PIPE                            | PICADY   |               | -              | İ           |         | 141.57              | COXTROL      | <u> </u> | н        | ADW            | OUTLET      | COMP       |                |                   | -1.5     | <u></u>            |                    |                    |   |
| TING DE L  | JRAL<br>1                       | 7        | ŝ             | SECTION        | SIZE        |         | IALES               | CONTROL      |          |          |                | VVILET      | CONTRO     | L HW           | HI I NO           | 1        | #OTIET             | ₹ .                | <u>,</u>           | •   |
| SIZE COMONETE STATEMENT OF THE STATEMENT | TRUCTURAL<br>PLATE<br>(virth(s) | VEXTICAL | KITCACO       | 5 GK3          | D           | a       | ₽.<br>H.A.          | нw           | К.       | H        | đç             | 4 <u>+D</u> | τw         | h <sub>o</sub> | LS <sub>0</sub> . | -HW      | HW.                | CDMT MOLLING<br>HW | OUTLET<br>VELOCITY | COMMENTS  |
| Ke Confilement 0.2 0.5 0.1   | 1 61                            |          |               | 0.5            | 0           | ,       |                     | İ            |          |          |                | -           |            |                |                   | •        |                    | COM                | 31                 |   |
|  | -                               |          |               |                |             |         |                     |              |          |          | _              |             |            |                |                   |          |                    |                    |                    |   |
| _15' X 13.8' set *pp   | rxxima                          | ely      | 2 <u>'. i</u> | elow.          | the c       | xistir  | g strea             | <u>n bed</u> | ļi       |          |                | <u> </u>    |            |                |                   |          | <u> </u> ;         |                    |                    |   |
| Equivalent 14' span  | x 13'                           | rise     | ,             |                |             |         |                     |              |          |          |                |             |            |                |                   |          |                    |                    |                    |   |
| X  |                                 |          |               |                | 13          | 95      | 0,2                 | 2,6          | 0.7      | 0.2      | 1,3            | 7.1         | 1.4        | 7.1            | 2.7               | 4.6      | 0.4                | 4.6                | 6.0                | Barrel velocity   |
| X  |                                 |          |               |                | 13          | 625     | 0.5                 | 6.5          | 0.7      | 0.75     | 3.9            | 8.4         | 3.8        | 8.4            | 2.7               | 6.5      | 0.5                | 6.5                | . 9,4              | Barrel velocity   |
|  |                                 |          |               |                |             |         |                     |              |          |          |                |             |            |                |                   |          |                    |                    |                    |   |
| <del>    </del>  |                                 |          |               |                |             |         |                     |              |          |          |                |             |            |                |                   |          |                    |                    | <del>-</del> -     |   |
|  |                                 |          |               |                | ,           | '       |                     |              |          |          |                |             |            |                |                   |          |                    |                    | j                  | <u> </u>  |
| SUMMARY AND RECOMMEN   |                                 | 0 (-     |               |                | L -         | 20.64   | t. (n =             | U WE         |          | + 5      | <br>]          |             |            |                |                   |          |                    |                    |                    |   |
| Q2 = 95 cfs V<br>Q50 = 500 cfs V   | b = 6.9<br>b = 9.4              |          |               | @<br>@         |             |         | c. (n =<br>ft. (n = |              |          |          |                |             |            |                |                   |          |                    |                    |                    |   |
| ,  |                                 |          |               | •              |             |         |                     | ,            |          |          |                |             |            |                |                   |          |                    |                    |                    |   |
| Assume the 10' Ø pi  | pe wou                          | 1d ca    | iny           | 125 c          | fs du       | ring a  | a Q50.              |              |          | •        |                |             |            |                |                   |          |                    |                    |                    | ·   |

O BEE CHITERE BILKETER FOR BOWD PARES -

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timt fattar firte.

O to in tal mente at

| En 10-154<br>(Apr 6-71) |                           |            |               |                   | С        | ะบ       | LV            | EF           | 27             | DE                   | SIC              | ЭŅ              | 5       | зН             | EET              | <u> </u>      |                |                   |            |  |                   | FEDERA   | ARTHENT OF TRANSPORTATION OF TRANSPORTATION OF TRANSPORTATION OF TRANSPORTER WASHINGT |
|-------------------------|---------------------------|------------|---------------|-------------------|----------|----------|---------------|--------------|----------------|----------------------|------------------|-----------------|---------|----------------|------------------|---------------|----------------|-------------------|------------|--|-------------------|----------|---|
|                         |                           |            | जस्त <b>ा</b> |                   |          |          |               | ÷            |                | 13-D                 | <del></del>      | ·               | ·<br>   | _              | Cert             |               |                |                   |            |  |                   | -        | 13-D<br>STATSOR   |
| Meach                   | am_C                      | <u>mek</u> | ti oten       | 84.06             |          |          |               |              |                | 22.4                 | 11414K 24        |                 | 14441   | <b>PECEL</b>   | , t              | RIKIRA        |                |                   |            |  | `                 |          |   |
| USGS                    |                           |            |               |                   |          | วุก"     |               |              |                |                      | <u> </u>         |                 |         | _              |                  |               |                |                   |            |  |                   |          |   |
|                         |                           |            |               |                   |          |          | 35            |              |                | 11                   | 35E              |                 |         | _ [            | 4K#+-            | <del></del> - |                |                   |            |  |                   | `        | \   |
|                         |                           | . Lecate   | 14            |                   |          |          | 10            | E1109        |                | 1174147              | L                | 4               | BERIOL  | •              | 1                |               | F              |                   |            |  |                   |          |   |
|                         | D.                        |            | litata        |                   |          |          |               |              |                | 11/9/                |                  |                 |         | _              | <u> </u>         |               | <del></del>    | <del></del>       |            | ~~   | <u>~</u>          |          | \ i*  |
|                         |                           |            | (544)         | 91                |          |          | ·             |              |                | 1.5                  |                  |                 |         | -              | <u>9.ex 367(</u> | . ,           |                |                   |            | <u>'/'</u> , .•                                |                   |          | nr 3668.  |
| °-2 —                   | 9                         | 5 cfs      |               |                   |          | ۱        | <b>**</b> 2 - |              |                |                      |                  |                 |         |                | SCHYSKE:         | Smaj          | 1 bou          | ılders            | , gra      | vels,  | and c             | obbles   | located   |
| 0-1-                    | _6                        | 25 cf      | s             |                   | ·.       | _ ;      | W-44 _        |              |                | 4.1'                 |                  |                 |         |                | <u>within</u>    | the the       | barre          | <u>:</u> ]        |            |  |                   |          | ·   |
|                         |                           | CUL        | VERT          | DES               | CRIP     | TION     | 1             | Ţ            |                |                      |                  | r <del></del> - | Н       | EADW           |                  | COMP          |                |                   |            |  |                   |          |   |
|                         | OX.                       | ש          | $\overline{}$ | ੜਾ∸               | 1        |          | SECTION       | SIZE         |                | IKLET                | COMINGE          |                 | Г       | 1              | OUTLET           | COXERO        | LHW            | • H11%            | LSo        | 133101   | ž.                | <u> </u> |   |
| SIZE<br>INCHES          | CCNCR<br>REGOVE<br>PAGJEG | PROJECTIN  | MITCAED       | STRUCTUR<br>PLATE | VERTICAL | MITCHED  | CND. SE       | reet         | . Q            | D<br>HA.             | НW               | K.              | н       | 4.             | 4,10             | τw            | ħ <sub>0</sub> | LS <sub>o</sub> . | ·HW        | HW.  | COMTROLLING<br>HW | VELOCITY | COMMENTS  |
| Coefficient -           | 0.2                       | 0,9        | 1.0           | 0.7               |          | 0.7      | 0.5           |              | <u> </u>       |                      |                  |                 |         |                |                  | <u> </u>      | •              |                   | <u> </u> . | ļ. <u>.                                   </u> | 8_                | ° ≥      | <u>-                                      </u>  |
| 20' X 20                | )' sq                     | uash       | pipe          | set               | арра     | oxir     | ately         | 3' t         | p 5' l         | elow th              | e exist          | ng si           | ream    | ped            |                  |               |                |                   |            |  |                   |          |   |
| Equivale                | nt 2                      | o' si      | an X          | 16'               | ris      | •        |               |              |                |                      |                  |                 |         |                |                  |               |                |                   |            |  |                   |          |   |
|                         |                           |            | χ             |                   |          |          |               | 16           | 95             | 0.1                  | 1.6              | 0.7             | 0.1     | 1.6            | 8.8              | 1.5           | 8.8            | 2.2               | 6.7        | 0.4  | 6.7               | 5.3      | Barrel velocity   |
|                         |                           |            | Х             |                   |          |          |               | 16           | 625            | 0.4                  | 6.4              | 0.7             | 0.6     | 3.2            | 9.1              | 4.1           | 9.1            | 2.2               | 7.5        | 0.5  | 7.5               | . 8.7    | Barrel velocity   |
|                         |                           |            |               |                   |          |          |               |              |                |                      | _                |                 |         |                |                  |               |                |                   |            |  |                   |          |   |
|                         |                           |            |               |                   |          |          |               | -            |                |                      |                  | , <b>-</b>      | <b></b> |                |                  |               |                |                   | _          |  |                   |          |   |
| Q2 = 95<br>Q50 = 60     | cfs                       |            | ٧b            |                   | 3 fp     | os<br>os | @<br>@        | db =<br>db = | = 2.0<br>= 5.1 | ft. (n =<br>ft. (n = | 0.045)<br>0.045) | culve<br>culve  | ert ba  | arrel<br>arrel | ł                |               |                |                   |            |  |                   | !        | · · · · · ·   |
|                         |                           |            |               |                   |          |          |               |              |                | 711 (2111/2          |                  |                 |         |                |                  |               |                |                   |            |  |                   |          | ·   |

| 74 14-114<br>(Av. 6-11) |                                    |              |  |                |           | :U              | LV          | EF               | · · ·    | DE          | SIC        | -N       | S        | SH-E       | EET                | ·        |                |                 |                  |          |                   | FEDERAL | . ARMENT OF TRANSPORTATION A HIGHWAY ARMING THE HIGH THE |
|-------------------------|------------------------------------|--------------|--|----------------|-----------|-----------------|-------------|------------------|----------|-------------|------------|----------|----------|------------|--------------------|----------|----------------|-----------------|------------------|----------|-------------------|---------|---|
|                         |                                    |              | अस   |                |           | ·<br>           |             |                  |          | 13-E        |            |          |          | -          | Effati             |          |                |                 |                  |          |                   | _       | 13-E  |
| Shee                    | p Cre                              | ek           |  |                |           |                 |             |                  |          | 3.0         | iáinage ga |          | SQUAC    | mc11       | *****              | MIKING   | 4              |                 | $\overline{}$    |          |                   | \       |   |
| 11900                   | Ouad                               |              |  | HAMI<br>IADI ( | hrear     | าก"             |             |                  |          | •           |            |          |          |            |                    | •••      |                | /               |                  |          |                   |         |   |
|                         | Quad                               | <del>'</del> |  | HAP            | <u> </u>  | <del>,,,,</del> |             |                  |          |             |            |          |          | — <u>}</u> | AKW•               |          |                |                 |                  |          |                   |         |   |
| ļ.———                   |                                    |              | <del></del>                                  |                |           |                 | 35          | CTASE            |          | 18          | 35E        | 11       | D14:0:11 |            |                    |          |                | /               |                  |          |                   | `       |   |
|                         |                                    |              |  |                |           |                 |             |                  |          |             |            |          |          |            |                    |          | /-             | —               |                  |          |                   |         |   |
|                         |                                    |              | nair   |                |           |                 |             | -                |          | 11/0        |            |          |          | _          | 1_                 |          | /              | <del></del> -   |                  | ~~~      | - <del>-</del>    |         | _ \ 'i"—  |
| l ——-                   |                                    | COMIL        | no_  | BT .           |           |                 |             |                  |          | 11/9        | -          |          |          | -          | <u>are 3519</u>    | / بالم   | Cred           | -50             | 0.053            | 2'/      | 60                |         | 3515.8  |
| 9.5                     | 2                                  | cfs c        | <u>.                                    </u> |                |           | ፣               | ¥*2 '-      |                  |          | 0.71        |            |          |          |            | U E M'YEK E F      |          |                |                 |                  |          |                   |         | <u> </u>  |
| Q-14                    | 1.                                 | 50 ct        | Fs   |                |           | 1               | ¥***        |                  |          | 2.3'        |            |          |          |            |                    |          |                |                 |                  |          |                   |         | · •   |
|                         | <u> </u>                           |              |  | DES            | CRIP      | TION            |             | ī                | r        |             |            |          | н        | EADWA      | TER                | COMP     | UTAT           | ION             |                  | <u> </u> | ···               |         |   |
|                         |                                    | HET          | λι –   | PIPE           | HEAD      | WALLS           | 3           | 1                |          | INLET       | CONTROL    | I        |          | CHPHA      | OUTLET             |          |                |                 | -LS <sub>o</sub> |          |                   |         |   |
| SIZE<br>INCHES          | CONCRETE<br>BROOVE-EX<br>PROJECTIM | PROJECTING   | WITEAED                                      | PLATE<br>PLATE | VERTICAL  | MITERED         | END SECTION | SIZE<br>D<br>rtt | <b>Q</b> | <u>нж</u>   | нw         | Ke       | н        | ďc         | <u>d</u> c+D<br>2⋅ | τw       | h <sub>ū</sub> | LS <sub>o</sub> | -HW              | HW.      | CONTROLLING<br>HW | OUTLET  | COMMENTS  |
| Ke Coefficient -        | 0.2                                | 0.3          | 0.7  | 0.7            |           | 1.0             | 0.5         | 0                | ·        | <u> </u>    |            |          |          | ,          | <u> </u>           | c        | 0              |                 |                  |          | 8                 | °ÿ      |   |
| 7'ø                     |                                    |              | _X_  |                | _         |                 |             | 7                | 20,      | 0,2         | 1.4        | 0,7      | 0.1      | 1.0        | 4.0                | 0.7      | 4.0            | 3.2             | 0.9              | 0.1      | 1.4               | 9.0     | Barrel velocity   |
| 7'Ø                     |                                    |              | χ  |                |           |                 | <u> </u>    | 7                | 150      | 0.7         | .4.9       | 0.7      | 0.6      | 3.2        | 5.1                | 2.3      | 5.1            | 3.2             | 2.5              | 0.4      | 4.9               | 16.0    | Barrel velocity   |
|                         |                                    |              | ·-<br>                                       |                |           |                 |             |                  |          |             |            |          |          |            |                    |          |                |                 |                  |          |                   |         |   |
|                         |                                    |              |  |                |           |                 |             |                  |          |             |            |          |          |            |                    |          |                |                 | · · · ·          |          |                   | ,       |   |
|                         |                                    |              |  |                |           |                 |             |                  |          |             |            |          |          |            | ~~~~~              |          |                |                 |                  | 1        |                   |         |   |
| <u> </u>                |                                    |              |  |                |           | <u> </u>        |             |                  |          | <del></del> |            |          |          |            |                    |          |                |                 |                  |          |                   |         |   |
| SUMMARY .               |                                    |              |  |                | <b></b> - |                 | ш           | L                | L        | J           |            | <u> </u> | 1        |            | · —                | <u> </u> |                |                 | <u> </u>         |          | L                 | 1       | ·-···   |
| Q2 = 20 (               |                                    |              |  |                |           |                 |             |                  |          | ft. (n =    |            |          |          |            |                    |          |                |                 |                  |          |                   |         |   |
| Q50 = 150               | ocfs)                              |              | ٧b   | = 16.          | .0 fį     | ps              | 0.          | db =             | 2:2 1    | ft. (n =    | 0.024)     | culve    | rt bai   | rrel       |                    |          |                |                 |                  |          |                   |         |   |
|                         |                                    |              |  |                |           |                 |             |                  |          |             |            |          | -        |            |                    |          |                |                 |                  |          |                   |         |   |
|                         |                                    |              |  |                |           |                 |             |                  |          |             |            |          |          |            |                    |          |                |                 |                  |          |                   |         | _   |
| O att telates           |                                    |              |  |                |           | <del></del>     |             |                  |          | 186 016153  |            |          |          | <u>.</u>   | ·<br>              |          |                |                 |                  |          |                   |         |   |

| f m e4 - 614<br>64e: 8 - 766 |                                      |              | <del></del>        | . ,                 | C            | ะบ            | LV                   | EF         | <del>.</del><br>?Т | DE           | SIC         | 3Ņ       | S   | Н              | EET                                    | <b>-</b>  | •          |                   | <del></del> . | •                 |                   | PEDEAKL                                      | RTMENT OF TRANSPORTATION<br>HIGHWAY ADWINISTRATION?<br>EN VANCOUVER, WASHINGTI |
|------------------------------|--------------------------------------|--------------|--------------------|---------------------|--------------|---------------|----------------------|------------|--------------------|--------------|-------------|----------|---|----------------|--|-----------|------------|-------------------|---------------|-------------------|-------------------|--|--|
|                              |                                      |              | iitel              |                     | ·            | •             |                      |            |                    | 12-A         |             |          |   | -              | áreas                                  | F) 0-4    |            |                   |               |                   |                   |  | 12-A   |
| Canyo                        | on Cr                                | ek           | <u>BERËAM</u>      | 84.04               |              |               |                      |            |                    | 27.8         | 11)MA44 A4  |          | Lawet   | MW C1          | 2'                                     | MINIMA    | ĸ          |                   |               |                   |                   | \  |  |
| USGS                         | Quad                                 |              |                    |                     | egon         | ı"            |                      |            |                    | _            | :           |          |   | ı              |  |           |            |                   | <i>.</i>      |                   |                   |  |  |
|                              |                                      |              |                    |                     | -            |               | 2                    |            |                    | 160          | 32E         |          |   | -[             | AH)Y • .                               |           |            |                   |               |                   |                   | /  |  |
|                              |                                      | 10645        | 94                 |                     |              |               |                      | E1H4       |                    | 165          | J <u>ZE</u> | 14       | he nibs &c                                    | -              |  |           |            | _                 |               |                   |                   |  |  |
|                              |                                      | · <u></u> 17 | 175=15             |                     |              |               |                      |            |                    | <b>0</b> 4 i |             |          | <del></del>                                   |                |  |           | /.         |                   |               | $\overline{\sim}$ | — <u>—</u><br>~   | <del>-</del>                                 |  |
|                              | Br                                   |              | ng                 |                     |              |               |                      |            |                    | 11/10        | )/88        |          | <u>,                                     </u> | _              | <u> 428</u>                            | <br>39.5ノ | Seat       |                   | 0.020'        | <u> </u>          | 557               | <del></del>                                  |  |
| 0.0                          |                                      | 5 cf         |                    | <b>\$</b> 7         |              |               | **2 '-               |            |                    | 2.7'         |             |          |   |                | ************************************** | 210,      | <b></b>    | - 34              |               |                   |                   |  | <u>ne. 4288.4</u>  |
| ۰۰.5 —                       |                                      |              |                    | •                   | -            | _ '           | • · · ·              |            |                    | 4.8'         |             |          |   | -              | #CHARKE                                |           | ····       |                   |               |                   |                   |  |  |
| 6-11                         | 6.                                   | 75 cf        |                    |                     |              |               | ****                 | ·····      |                    | 4,8          |             |          |   | <u> </u>       |  | ·         |            |                   |               |                   |                   |  |  |
|                              |                                      | MET          | VERT               | PIPE                | P-EAD        | TIOH<br>WALLS | T =                  | 1          |                    | LYLET        | CONTROL     | т        | H   | EADW           | ATER<br>BUILET                         |           | TATU       |                   | -15.          | •                 |                   | {  |  |
| A17.5                        |                                      | 17.00        | ន្ទ                | 7 K                 | =            | e K           | \$ ECTION            | SIZE       |                    | - INCEL      | CONTROL     | 1        |   |                | DOILE                                  | LUMIN     | ""         | 11110             | 1             | 01111             | ¥ .               |  | •  |
| SIZE                         | CCHCAETE<br>4x00VE-END<br>PROJECTIVE | PROJECTING   | MITERED            | STRUCTURAL<br>PLATE | VERTICAL     | HITERED       | ENO. SE              | 1          | a                  | HW<br>D      | нw          | K.       | н   | đ <sub>c</sub> | <u>¢c 10</u><br>2:                     | TW        | No.        | LS <sub>o</sub> ʻ | ·HW           | HW.               | CONTROLLING<br>KW | OUTLET<br>VELOCITY                           | COMMENTS   |
| a Coefficient-               |                                      | 0.9          | 0.7                | 0.7                 | 0.5          | 0.1           | 0.5                  | rttr       |                    |              |             |          |   |                | -                                      |           | ١.         |                   |               | -                 | CO#17             | 햙  |  |
|                              |                                      |              |                    |                     | _            |               |                      | 1          |                    |              | 1           | 1        |   |                |  |           |            |                   |               |                   |                   |  |  |
| 2.6° X                       | 8.1'                                 |              | X_                 | <del> </del>        |              |               | <b> </b> -           | 8.1        | 215                | 0,6          | 4.9         | 0.7      | 0.5   | 2.5            | 5.3                                    | 2.7       | 5.3        | 1.1               | 4.7           | 0.6               | 4.9               | 11.1   | Barrel velocity  |
| 2.6' X                       | 8.11                                 |              | Х                  |                     |              |               |                      | 8.1        | 675                | 1.2          | 9.7         | 0.7      | 2,0   | 4.7            | 6.4                                    | 4.8       | 6.4        | 1.1               | 7.3           | 0.9               | 9,7               | 15.6   | Barrel velocity  |
|                              |                                      |              |                    |                     |              |               |                      | 1          | ·                  |              |             |          |   |                |  |           |            |                   | İ             |                   |                   | -  | •  |
| <del></del>                  |                                      |              | ļ <u>.</u>         |                     |              |               |                      | . <b> </b> | <u> </u>           | ļ            | <u> </u>    | <u> </u> | :   |                |  | ļ         |            |                   | ļ             | <b> </b>          |                   | <u>                                     </u> | ·  |
|                              | [                                    |              |                    |                     |              |               |                      |            | ]                  |              | •           |          |   |                |  |           |            |                   |               |                   | •                 | ļ. <b>ļ</b>                                  |  |
| _                            |                                      |              |                    |                     | <u> </u>     | _             | i                    |            | ļ                  |              |             | 1        |   |                | 1                                      |           |            |                   |               |                   |                   |  |  |
|                              |                                      |              | <u> </u>           | <u> </u>            | <u> </u>     | <del> </del>  | ļ                    | ļ.—        | <del> </del>       | ļ            | ļ           | <u> </u> |   |                | <del> </del> -                         | -         | ļ          |                   | [             |                   |                   |  |  |
|                              |                                      |              |                    |                     |              |               |                      |            |                    |              |             |          |   |                |  |           |            |                   |               |                   |                   |  |  |
| SUUMARY                      |                                      |              |                    |                     | 1 <i>E</i> - |               | a                    | <u> </u>   | 2 0 4              | · /n =       | U U347      | ~u3      | er ban  | 1              | 1                                      | 1         | . <i>,</i> |                   | I             | 1                 |                   | ·  | <del>-</del>   |
| )2 = <b>215</b><br>)50 = 675 | ors<br>Sofs                          |              | VD:                | - 11.<br>= 15.      | гр<br>6 fn   | is<br>IS      | 0                    | db≃        | 3.9 f              | t. (n =      | 0.024)      | culve:   | rt bar<br>rt bar                              | rel<br>rel     |  |           |            |                   |               |                   |                   |  |  |
| ,-3 0/0                      | , .                                  |              |                    | , 51                | - · P        | _             | - ,                  |            |                    | •••          | ,           | _ 5      |   |                |  |           |            |                   |               | -                 |                   |  |  |
|                              |                                      |              |                    |                     |              |               |                      |            |                    |              |             |          | •   |                |  |           |            |                   |               |                   |                   |  |  |
|                              | <del>.</del>                         |              | •41                |                     |              |               |                      |            |                    |              |             |          |   |                |  |           |            |                   |               |                   | <del> </del>      |  |  |
| 111 (5111)<br>111 (5111)     | TERZIOR<br>I Ditali                  | {4\$ \$1     | IIME FI<br>Ca CICO | (111)<br>(111)      | € 1          | RITE ON       | 381 3113<br>12 35714 | II,<br>it  | المنابة<br>10 يان  | til glilli   | *1          |          |   |                |  |           |            |                   |               |                   |                   |  |  |

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| 24 10 - 124<br>[her 0 - 12]           | <del></del>                          |                        | -           | <u>.</u>            | C        | ะบ       | LV                    | EF       | ?T            | DE                  | SIC         | ξŅ  | S       | SI-18          | ĒET              | Γ             |                | ~-                |                   |  |                   | UJ DEP<br>FEDERAL<br>REGION | TRANSPORTATION HIGHWAY TO THE TRANSPORTATION TO THE TRANSPORT OF THE TRANSPORTATION TO T |
|---------------------------------------|--------------------------------------|------------------------|-------------|---------------------|----------|----------|-----------------------|----------|---------------|---------------------|-------------|---|---------|----------------|------------------|---------------|----------------|-------------------|-------------------|--|-------------------|-----------------------------|--|
|                                       |                                      | ) pi                   | 5721        | alut                |          | •        |                       | <u>.</u> |               | 12-B                | EA .        |   |         | -              | <u>ti tva</u>    | †+ c+-        |                |                   |                   | •                                      |                   | -                           | 12-B<br>STATION  |
| Midd                                  | <u>le Fo</u>                         | rk o                   | f Car       | IXOU                | Cree     | <u>k</u> |                       |          |               | 11.9                | 1419446 44  |   | I I MTC | P44.21         | 12'              | MINIMU        | 4              |                   |                   |  | \                 |                             |  |
| USGS                                  | Quad                                 | - ";                   | Senec       | a, O                | rego     | л"       |                       |          |               |                     | :           | <u>.                                     </u> |         |                |                  |               |                | /                 |                   |  |                   |                             |  |
|                                       |                                      | •                      |             | . F. T.             |          |          | 2                     |          |               | 1<br>16S            | 32E         |   |         | _{             | <br>             |               |                |                   |                   |  |                   |                             |  |
|                                       | <del>-</del>                         | LOCATO                 | 04          | <del>-</del> -      |          |          |                       | CTION    |               | . 1014014           | 4444        | c   | ME KIMA |                |                  |               | /              |                   |                   |  |                   |                             |  |
|                                       |                                      | ·                      | 11426       |                     |          |          |                       | _        |               |                     |             |   |         |                |                  |               |                |                   |                   | ~~                                     |                   |                             | _/   |
|                                       | В                                    | rown:                  | ina         |                     |          |          |                       |          |               | 11/9                | /88         |   |         | ļ              | 125              |               | <del>/</del> - | <del></del>       |                   |  |                   |                             |  |
|                                       |                                      | Ç#                     | CCX TO      |                     |          |          |                       | _        |               | 7.41                | · · · · · · |   |         | _              | <u>n er 435.</u> | <u>3.1.</u> / | Gred           | a-\$a•_           | J. UZZ            | <u>/'</u> , . •                        | <u>-9</u> (F      |                             | nr. 4351.7   |
| <b>.</b> .5 —                         |                                      | 10 c                   | <u>rs</u> _ |                     |          | _ ·      | <b>*</b> *2 -         |          |               | 1.4'                | <del></del> |   |         | —Ì             | REMARKIL         | Small         | boul           | ders.             | grave             | els. ar                                | nd cob            | bles v                      | vithin   |
| 9-++                                  | 3                                    | 50 ci                  | fs          |                     |          | ፣        | ¥*H _                 |          |               | 2.5'                |             |   |         |                | tbe              | barre         | ا              |                   |                   | ······································ |                   |                             |  |
| · · · · · · · · · · · · · · · · · · · |                                      |                        | VERT        | DE5                 | CRIP     | HOIT     | -                     | ]        |               | Τ                   |             |   | Н.      | EADWA          | TER              | COMP          | UTAT           | ION               |                   |  |                   |                             | ······································   |
|                                       | ~ S =                                | HET<br>S               | 1           | PIPE                | HEAD     | WALLS    | ğ                     | SIZE     | ·             | INLET               | COXTROL     |   |         |                |                  | CONTRO        |                |                   | -L\$ <sub>0</sub> | ,                                      |                   |                             |  |
| SIZE                                  | CONCRETE<br>6400VE-END<br>PAOJECTING | PROJECTWO              | MITERED     | STRUCTURAL<br>PLATE | VERTICAL | MITERED  | END. SECTION          | חנו      | a             | р<br>НЖ             | КW          | K.  | н       | đ <sub>C</sub> | <u>dc 1D</u>     | 1 W           | ho             | LS <sub>o</sub> ' | ·HW               | HW.<br>D                               | COMTROLLING<br>RW | OUTLET<br>VELOCITY          | COMMENTS   |
| Ke Coefficient-                       | 0,2                                  | 0,9                    | 0.7         | 0.7                 | 0.5      | 1.0      | 0.5                   | 0        |               | <u> </u>            |             |   |         |                |                  |               | •              |                   |                   | <u> </u> .                             | 8                 | °>                          |  |
| <u>13,5' X</u>                        | 0.5                                  | 50                     |             | المراقعة            |          | , ,      | n' ba                 | ]<br>    | 10 OV         | ictina c            | troom be    |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
| 13.5 /                                | 0,5                                  | <u> 5e</u>             | գր,         | OXII                | la Ce    | y Z.     | 0 56                  | I W      | ie ex         | iscing s            | J COSII DE  | <u> </u>                                      |         |                |                  |               |                |                   |                   | <del> </del>                           |                   | 4                           | <del></del>  |
| <u>Eguivale</u>                       | <u>nt 6</u>                          | .5' ı                  | ise         | by 1.               | .5'      | spar     |                       | I        |               |                     |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
|                                       |                                      |                        |             |                     |          |          |                       |          |               |                     |             |   |         |                |                  |               |                |                   |                   |  | 0.5               |                             |  |
|                                       |                                      | _                      |             | X                   | <u> </u> | _        |                       | 6.5      | 110           | 0,4                 | 2.6         | 0.7   | 0.5     | 1.3            | 3.9              | 1.4           | 3,9            | 2,0               | 2.4               | 0.4                                    | 2.6               | 6.2                         | Barrel velocity  |
|                                       |                                      |                        |             | Х                   |          |          |                       | 6.5      | 350           | 0.8                 | 5.2         | 0.7   | 2,1     | 3.2            | 4.8              | 2.5           | 4.8            | 2.0               | 4.9               | 0.7                                    | 5.2               | -8.6                        | Barrel velocity  |
|                                       |                                      |                        |             |                     |          |          |                       |          |               |                     |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
|                                       |                                      |                        |             |                     |          |          |                       |          |               | <u> </u>            | ļ           |   |         |                |                  | <u> </u>      |                |                   |                   |  |                   | <u>-</u>                    |  |
|                                       |                                      |                        |             |                     |          |          |                       |          |               |                     |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
| SUMMARY                               | AND R                                | ECOMI                  | LENDA       | TIONS               | 1        | ·        | L                     | <u>[</u> |               | 1                   |             | L   |         |                |                  | I             |                |                   |                   | <b></b> _                              |                   |                             |  |
| Q2 = 110                              | cfs (                                |                        |             | Vb :                | = 6.1    | 2 fps    | ;                     | 0        |               | 1.8 ft.             |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
| Q50 = 35                              | 0 cf                                 | S                      |             | VD =                | = 8.6    | 6 fps    | <b>i</b>              | 6        | do =          | 3.3 ft.             | (n = 0.     | .045)   | culve   | t bai          | rel              |               |                |                   |                   |  |                   |                             |  |
|                                       |                                      |                        |             |                     |          |          |                       |          |               |                     |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |
| O BSE EVEYETE                         | P(44(1)                              | (i (4) (<br>(i) ) ) (i | lawes fo    | 7[E -               | O TI     | KET ESE  | 15 VEL101<br>VXI ((11 | ı,       | <u>dr 1 1</u> | toe arnita<br>An in | II          |   |         | •              |                  |               |                |                   |                   |  |                   |                             |  |
|                                       |                                      |                        |             |                     |          |          | -                     | •        | ı             |                     |             |   |         |                |                  |               |                |                   |                   |  |                   |                             |  |

| (4 M -   10          |                                      |             |            |                | C          | U                | LV   | EF   | ?<br>? T | DE                 | SIC          | ЗŅ             | S          | Н        | EET            | Γ                |                |  |                |          |  | FEDERAL            | ARTHENT OF TRANSPORTATION<br>HIGHWAY ADMINISTRATION<br>TEN VANCOUVER, WASHING |
|----------------------|--------------------------------------|-------------|------------|----------------|------------|------------------|--|--|----------|--------------------|--------------|----------------|------------|----------|----------------|------------------|----------------|--|----------------|----------|--|--------------------|---|
|                      |                                      | 346         |            | ilet           |            |                  |  |  |          | 12-C               |              |                | · ·        |          | ECEAT          | [+ <del>04</del> |                |  |                |          |  | _                  | 12-C  |
| Canyo                | on Cr                                | <u>ek</u>   | I I A CAM  | 1100           |            |                  |  |  |          | 11.5               | -419464 44   | 16.7           | 14MX       | ا<br>ا   | 7              | RIXIRO           | ¥              |  | $\overline{/}$ | <u></u>  |  |                    |   |
| USGS                 | Quad                                 | <u>- "S</u> | enec       | a <u>. O</u> r | ~egor      | )"               |  |  |          |                    | `            | <u> </u>       |            | ]        |                |                  |                | /  |                | -        |  |                    |   |
|                      |                                      |             | -          |                |            |                  | 1  |  |          | 16\$               | 32E          |                | ,          | _}       | A.             |                  |                |  |                |          |  | \                  | \   |
|                      |                                      | LOCATH      |            |                |            |                  | •  | ((10)  | -        | TEVALA             | 4.           | 46             | RC B)\$(1) | ١.       |                |                  | F              |  |                |          |  |                    |   |
|                      | Rr                                   | rowni       | nate<br>na |                |            |                  |  |  |          | 11/9/              |              |                |            | -        | 1              |                  | <u>/-</u> -    | <del></del>                                      |                | ~~       | ~~<br>~~   |                    | _\  |
|                      |                                      | C In        | cres       | Ďτ             |            |                  |  |  |          | 2.0                |              |                |            |          | ary 440        |                  |                |  |                | 7'7'•    | 113°   |                    | 4400.1  |
| a.5                  |                                      | )5 cf       |            |                |            | _ '              | * 2 -  |  |          | 3.6'               |              |                |            | -        | •              |                  |                |  |                |          |  | grav               | el_and  |
| G-10                 |                                      | 5 cf        | 5          |                |            | _ '              | *·* -  |  |          | 3,0                |              |                |            | _]       | <u>cob</u>     | bles y           | <u>vithir</u>  | <u>the</u>                                       | <u>culve</u>   | rt bar   | rel  |                    |   |
|                      |                                      | CUL         | VERT       | PIPE           |            |                  | <u> </u>   |  |          | 18151              | COXTROL      | T              | Н          | EADW     |                | COM              | PUTAT          |  | -LSA           | ···      | Ţ  |                    | •   |
| SIZE                 | CCHCAETE<br>BROOVE-END<br>PROJECTING | PROJECTING  | WITERED    | STAUCTURAL     | VERTICAL   | MITERED          | CHD. SECTION                                     | S12E<br>D  | Q        | HW<br>D            | нж           | K <sub>k</sub> | н          | 4,       | 4,10           | TW               | h <sub>a</sub> | LS <sub>0</sub>                                  | ·HW            | HW.      | CONTROLLING                                      | OUTLET<br>VELOCITY | COMMENTS  |
| a Coolikiaa          | 0.2                                  | 0,9         | 0.7        | 0.7            |            | 1.0              | 0.5  | 0  | <u> </u> |                    | ļ            | ļ              |            |          | ļ              | c                | 0              | <u> </u>   |                | ļ        | ₹  | 0.5                | •   |
| 0'Ø set              | i<br>appro                           | xima        | tely       | )<br>1՝ է      | elo.       | the              | exis   | ting:  | tream    | bed                |              |                |            |          |                |                  |                |  |                |          |  |                    |   |
| quivalen             |                                      |             |            |                |            |                  |  |  |          |                    |              | ,              |            |          |                |                  |                |  |                |          | $\prod$  |                    |   |
| quivaici             | U J.V                                | <u>, p</u>  | Pripe      |                | ╁─         |                  |  | <del> </del> -                                   |          |                    | <del> </del> | <del> </del>   |            | <u> </u> |                |                  | -              | ļ  |                |          | <del>                                     </del> |                    |   |
| •                    |                                      |             |            | X              | <u> </u> _ | _                |  | 9.5  | 105      | 0,3                | 2.9          | 0.7            | 0.2        | 2.5      | 6.0            | 2.0              | 6.0            | 2.0  | 4.2            | 0.4      | 4.2  | 6.5                | Barrel velocity   |
|                      |                                      |             |            | Х              |            |                  |  | 9,5  | 345      | 0.7                | 6.7          | 0,7            | 1.1        | 4.5      | 7.0            | 3.6              | 7.0            | 2.0  | 6.1            | 0.6      | 6.7  | 9.0                | Barrel velocity   |
|                      |                                      |             |            |                | Γ          |                  |  |  |          |                    |              |                |            |          |                |                  |                |  |                | }        |  |                    |   |
|                      |                                      |             |            |                |            | ļ                | <del>                                     </del> | <del>                                     </del> |          |                    | i —          | T              |            |          | <del> </del> - |                  |                | <del>                                     </del> |                |          |  |                    |   |
| SURMARY              | AND R                                | FCOR        | AE NO A    | TIONS          | <u> </u>   | l                | <u> </u>   | <u>.l</u>  |          |                    | <u> </u>     |                |            |          | L,             | l                | L              | !  |                | <u> </u> | <u></u>  | <u> </u>           | <u> </u>  |
| Q2 = 105<br>Q50 = 34 | cfs                                  |             |            | Vb = Vb =      | 6.5        |                  |  | @<br>@   |          | 2.7 ft.<br>4.8 ft. |              |                |            |          |                |                  |                |  |                | -        |  |                    |   |
|                      |                                      | _           |            |                |            |                  |  |  |          |                    |              |                |            |          |                |                  |                |  |                |          |  |                    |   |
| D IST COCKET         |                                      | 141 TI      | illed Pi   | 1111           | . 61       | #(1°14<br>(#( (1 | 35 Tubi  | 111.   | O to to  | IJ( \$2{11[1       | ΦĮ           |                |            |          | <del>'</del> - |                  |                |  |                |          |  |                    |   |

| fa weeps<br>[km Telff |                   |                 |           | ·  | C            | Ü       | LV            | EF         | ?T            | DE                   | ESIC   | 3N             | 5                | ы              | EET            | <u> </u> |             | •                 | • • •            |              |             | FEDERA   | ARTMERT OF TRANSPORTATION :<br>1. HIGHWAY ADMINISTRATION :<br>TEN VANCOUVER, WASHINGTON |
|-----------------------|-------------------|-----------------|-----------|--|--------------|---------|---------------|------------|---------------|----------------------|--|----------------|------------------|----------------|----------------|----------|-------------|-------------------|------------------|--------------|-------------|----------|---|
|                       |                   |                 |           | <br>Jukat  |              |         |               |            |               | 12-D                 | ta .   |                |                  |                | Ertan          |          |             |                   |                  |              | •           |          | 12-0<br>. station   |
| Ruby                  | Cree              | <u> </u>        |           | -4=  |              |         |               |            |               | 5.5                  | ##(## <b>#</b> ############################### |                | 140026           | PHLE3          | ~              | MINIRA   | ď           |                   |                  |              |             | \        |   |
| 11252                 | Orad              |                 | -         |  |              | ı       |               |            |               |                      | :  |                |                  | ļ              |                | •        |             |                   | /                |              |             |          |   |
|                       |                   | · <del>··</del> |           | ***  | <del>5</del> |         | 6             | -          |               | 115                  | 34E  |                |                  |                | )<br>}         |          |             |                   |                  |              |             |          |   |
|                       | <del>.</del>      | LOCATO          | 94        | <del>, -</del> -                                 |              |         |               | £1104      |               | 113                  | J4C  | ιί             | PEF1841          |                |                |          |             |                   |                  |              |             |          |   |
| ·                     |                   | . <u>,</u><br>स | lii i ( i |  |              |         |               |            |               | \$ A T               |  |                |                  |                |                |          |             |                   |                  | ~~           |             |          |   |
|                       |                   | ~owni           |           |  |              |         |               |            |               | 11/10                | 0/88   |                |                  |                | are 3726       | £ 1 /    | <del></del> | <del></del> -     | 0.020            | (/)          | - COL       | ·        |   |
| _                     |                   | cfs             |           | 84   |              |         |               |            |               | 1.0'                 |  |                |                  |                |                | ٠,       |             |                   |                  |              |             | :        | nr. 3724.3  |
| a.5                   | <del></del>       | <u>/ C[3</u>    | -         |  |              | — ¹     | <b>*</b> *2 - |            |               |                      |  |                | • • • •          | -              | ¥£ñv¥X1™       | Sma      | l bou       | ılders            | , gra            | veis.        | and c       | obbles   | within  |
| G-14                  | 1                 | 55 cf           | s         |  |              | _ 1     | ¥"H _         |            |               | 2.1'                 |  |                |                  |                | the            | uthre    | ert. ba     | meļ.              |                  | -            | <u> </u>    |          | •   |
| , <u> </u>            | _                 | CUL             | YC.       | PIPE   | ME AD        | TION    |               | -          |               |                      |  | ·              | К                | EADW           | ATER           |          | PUTAT       |                   |                  | <u> </u>     | 1           |          |   |
|                       | # <b>6</b> #      | TMG             | ខ         | ¥ :  | 7            | ê       | <b>1</b>      | SIZE       | ,             | IRLE!                | CONTROL  | <del> </del>   |                  | ι <del>·</del> | OUTLET         | CONTRO   | I HW        | • H t ho          | -LS <sub>0</sub> | ontitt       | 2           | Т.       | ·   |
| SIZE<br>INCHES        | CONCAL<br>NBOYT-E | PROJECTIVE      | MITERED   | STAUCTURAL<br>FLATE<br>(mredes)                  | VERTICAL     | MITERED | END. SECTION  | P CET      | ٥             | ъ<br>нж              | н₩   | K <sub>4</sub> | Ħ                | 40             | <u>dc+D</u> 2: | TW       | N₀          | LS <sub>o</sub> ' | ·HW              | HW.          | CONTROLLING | VELOCITY | COMMENTS  |
| Ke Contikient         | 0.2               | 0.9             | 1.0       | 1.0  | 0.5          | 0.7     | 0.5           |            | <del> </del>  | <del> </del>         | <del> </del>                                   | ļ              |                  |                |                | -        | •           | <b> </b>          | <b> </b>         | <del> </del> | 8_          |          | •   |
| 8' X 4'               | <u> </u>          |                 |           | X  |              |         |               | 4          | 40            | 0.4                  | 1.6  | 0.7            | 0.5              | 0.8            | 2.4            | 1.0      | 2,4         | 1.8               | 1.1              | 0.2          | 1.6         | 5.9      | Barrel velocity   |
| 8' X 4'               |                   |                 |           | Х  |              |         | :             | 4          | 165           | 1.1                  | 4.4  | 0.7            | 3.0              | 2.4            | 3.2            | 2.1      | 3.2         | 8. 1              | 4.4              | 1.1          | 4.4         | 8.5      | Barrel velocity   |
|                       | Į                 |                 |           | i  |              |         |               |            |               | ļ                    |  |                |                  |                |                |          |             |                   |                  |              |             |          | •   |
| <del></del> -         |                   |                 |           | <del>                                     </del> |              |         |               |            | - <del></del> |                      |  | <u> </u>       |                  |                | -              |          |             |                   | <del> </del>     | <u> </u>     | <u> </u>    |          |   |
|                       |                   |                 |           |  |              |         |               |            | <u> </u>      |                      | <br>   |                |                  |                |                |          |             |                   | <u> </u>         |              | [ <u> </u>  | ·        |   |
|                       |                   |                 |           |  |              |         |               |            |               |                      |  |                |                  |                |                |          |             |                   |                  |              |             |          |   |
|                       |                   |                 |           |  |              | -       |               |            |               |                      |  | -              |                  |                |                |          |             |                   |                  |              |             |          |   |
|                       | Ĺ.,               |                 |           | <u> </u>   |              |         |               |            |               |                      |  |                |                  |                |                |          |             |                   |                  |              |             |          |   |
| SUMMARY .             |                   |                 |           |  |              |         | •             |            |               |                      | 0.043  | ,              |                  | ,              |                |          |             |                   |                  |              |             |          |   |
| Q2 = 40<br>Q50 = 16   |                   |                 | ٧b        | = 5.9<br>= 8.5                                   | fps<br>fps   |         | (d<br>∂       | db =       | 2.7 (         | ft. (n·=<br>ft. (n = | 0.04) d  | ulver<br>บโงคร | t barı<br>t barı | nel<br>nel     |                |          |             |                   |                  |              |             |          |   |
| ψ30 - 10              | CI                | •               | טו        | - 0.0  | , , h2       |         | G             | <b>œ</b> ~ | ٠., ١         | C. (III -            | 3.07) (  | ui vei         | , Dail           | G I            |                |          |             |                   |                  |              |             |          |   |
|                       |                   |                 |           |  |              |         |               |            |               |                      |  |                |                  |                |                |          |             |                   |                  |              |             |          |   |
| O est contin          |                   |                 | A         |  |              |         |               |            |               | <del> </del>         |  |                |                  |                | <u>. ·</u>     |          |             |                   |                  |              |             |          |   |

| /# 18. (34<br>(84. 9-71) |                                      |            | <u> </u>          | •                   | C           | U        | LV                                    | EF                | ₹T                    | DE                   | SIC                 | ЭŅ             | S                    | SI-1          | EET               | -        |                |                 |         |                      |             | FEDERAL            | HISKMAY A    | TRANSPORTATION<br>DUMISTRATION<br>UVER, WASHINGTON |
|--------------------------|--------------------------------------|------------|-------------------|---------------------|-------------|----------|---------------------------------------|-------------------|-----------------------|----------------------|---------------------|----------------|----------------------|---------------|-------------------|----------|----------------|-----------------|---------|----------------------|-------------|--------------------|--------------|--|
|                          |                                      | 740        | net 1             | eret.               | ,           |          | · · · · · · · · · · · · · · · · · · · |                   |                       | 12-E                 | C4 .                |                | · .                  | - $ $         | ELEVAT            | 7104     |                | -               |         | _                    |             | _                  | 12-          | E  |
| Big_C                    | neck.                                |            | Hatta             | - 1100              |             |          |                                       | <del></del>       | · <del></del> · · · · | 30.7                 | 96394 <b>6</b> € 44 | 14             | 15441                | <b>₽</b> 1,61 |                   | MIKIMU   | <b>K</b>       |                 |         |                      |             |                    |              |  |
| USGŞ (                   | Quad                                 |            |                   |                     |             |          |                                       |                   |                       |                      | :                   |                |                      | _             |                   |          |                |                 |         |                      |             |                    |              |  |
|                          |                                      |            | •                 |                     |             |          | 21                                    | CTH S             | ·                     | 9\$                  | 32E                 |                |                      |               | AHY               |          |                |                 |         |                      |             | \                  |              |  |
|                          |                                      |            |                   |                     |             |          | 16                                    | C1101             |                       | . 1074145            | #4k                 | IC             | <b>B</b> ( 8   8   4 | ٠             | i                 |          | F              |                 |         |                      |             |                    | 7            |  |
|                          | Dv.                                  |            | ii <del>iii</del> |                     |             |          |                                       |                   |                       | 11/10                |                     |                |                      |               | 1                 |          | <u>/-</u> :    | <del></del> -   |         | ~~<br>~~             | <u></u>     |                    | _ \          | j*.—   |
|                          |                                      | ownir      |                   |                     |             |          |                                       |                   |                       | 841                  |                     |                |                      |               | ary 326           | •        |                |                 |         | 4 <sup>1</sup> /, 1• |             |                    |              | <u>nn 3260.4</u>                                   |
| ئ.ه                      | - 23                                 | 0 cfs      | <u> </u>          |                     | <del></del> | _ T      | <b>*</b> *2 -                         |                   |                       | 1.8'                 | <del> </del>        |                |                      | -             | -                 |          |                |                 |         |                      |             |                    | within_      |  |
| Q+++                     | _72                                  | 5 cf:      | 5                 |                     | -           | <u> </u> | ¥*** _                                |                   |                       | 3.4'                 |                     |                |                      | <u> </u>      | the               | culve    | rt bar         | mel.            | Also    | some                 | bedro       | ck is              | exposed.     |  |
|                          |                                      | CUL<br>PE1 | ĀL                | PIPE                | - EAD       | WALLS    |                                       | {                 |                       | 191 FT               | CONTROL             | 1              | Н                    | EADW          | ATER<br>OUTLET    |          | PUTAT<br>DL HW |                 | -LSn    | <del>_ :</del>       | Ι           |                    | i            |  |
| S(ZE                     | CCMCRETE<br>BADOVE-END<br>PROJECTIME | PROJECTIVO | WITERED           | STRUCTURAL<br>PLATE | VERTICAL    | MITERED  | END SECTION                           | SIZE<br>D<br>PLET | Q                     | HA                   | нж                  | Ke             | н                    | 40            | d <sub>c</sub> +0 | TW       | Г              | LS <sub>0</sub> | ·HW     | HW.                  | CONTROLLING | OUTLET<br>VELOCITY | COI          | KMENTS   |
| Ke Coallkian             |                                      | 0.3        | 0.7               | 0.7                 | 0,5         | 0.7      | 0.5                                   | 0                 | <u> </u>              |                      | <u> </u>            |                |                      |               | <u> </u>          |          |                | ļ               | ļ       | ļ                    | ğ           | 05                 | <u></u>      | <del></del> -                                      |
| 12' X 7'                 |                                      |            |                   | Х                   |             |          | ]                                     | 7                 | 230                   | 0.6                  | 4.2                 | 0.7            | 8.0                  | 2,1           | 4.6               | 1.8      | 4.6            | 2.6             | 2.8     | 0.4                  | 4.2         | 10.8               | Barrel       | velocity   |
| 12' X 7'                 |                                      | -          |                   | Х                   |             |          |                                       | 7                 | 725                   | 1.5                  | 10.5                | 0.7            | 6.7                  | 4.9           | 6.0               | 3.4      | 6.0            | 2.6             | 10.1    | 1.4                  | 10.5        | 14.7               | Barrel       | velocity   |
| 12 A /                   |                                      |            |                   | 1-                  |             |          | <u> </u>                              | +                 |                       | 11.5                 | ,,,,,,              |                | -                    |               | +                 |          | _              | _               | _       | -                    | <b>├</b>    |                    | <del>-</del> | <del>.</del> -                                     |
|                          |                                      |            |                   |                     |             |          | <u> </u>                              | <u> </u>          |                       | ļ                    | ļ                   | ļ              | · .                  |               | <u> </u>          | <u> </u> | <u> </u>       | <u> </u>        | ļ       | ļ                    |             | <b> </b>           |              |  |
|                          |                                      |            |                   |                     |             |          |                                       | Ì                 |                       |                      |                     |                |                      |               |                   |          |                |                 |         |                      |             |                    |              |  |
|                          |                                      |            |                   |                     |             |          |                                       |                   |                       |                      |                     |                |                      |               |                   |          |                |                 |         |                      |             |                    | · <b>-</b> " | ·  |
|                          |                                      |            | _                 |                     |             |          |                                       | <del>  -</del>    |                       | -                    |                     | <del> </del>   |                      | <b></b>       | <del> </del> -    |          | -              |                 | _       |                      |             | -                  |              |  |
|                          |                                      |            | 45115             |                     |             |          | <u> </u>                              |                   |                       | <u> </u>             | <u> </u>            |                |                      | l             |                   |          |                |                 | <u></u> | L                    | <u></u>     | L                  |              | · · · · · · · · · · · · · · · · · · ·              |
| Q2 = 230<br>Q50 = 72     | cfs                                  |            | Vb :              | = 10.4<br>= 14.     | 8 fps       | s<br>s   | @<br>@                                | db =              | 2.2 f<br>4.6 f        | ft. (n =<br>ft. (n = | 0.040)<br>0.040)    | culve<br>culve | rt bar<br>rt bar     | rel<br>rel    |                   |          |                |                 |         |                      |             |                    |              |  |
|                          |                                      |            |                   |                     | ,           |          |                                       |                   |                       |                      |                     |                |                      |               |                   |          |                |                 |         |                      |             |                    |              |  |
| O est conte              | BILTET                               | (t 141 i   | iolai f           | u(s                 | C E         | ×(1:  1  | is sue                                | F2,               |                       | til state            | Nf.                 |                |                      |               |                   |          |                |                 |         |                      |             |                    |              |  |
| est dist er              | #E #5164                             | 16F 73     | C# {F(1           | (112                |             | (a) (a)  | ORI USI                               | •                 |                       | au ir                |                     |                |                      |               |                   |          |                |                 |         |                      | ·           |                    |              |  |

| \$4 00-164<br>(40-4-16) | -                | •          |               |                     | 0        | Ü          | LV          | EF        | ?T  | DE       | ESIC                 | ЭŅ           |           | эн      | EET      | - ;           | -7             | 7                 |               |               |                | PEGEAN             | ARTMENT OF TRANSPORTATION ( NIGHWAT ADMINISTRATION) TEN VANCOUVER, WASHINGTON |
|-------------------------|------------------|------------|---------------|---------------------|----------|------------|-------------|-----------|-----|----------|----------------------|--------------|-----------|---------|----------|---------------|----------------|-------------------|---------------|---------------|----------------|--------------------|---|
|                         | - 4:             | :<br>:     | गरा           | klui.               | ,        | <i>.</i>   | <del></del> |           |     | 12-F     |                      |              |           | -       | £r £ ¥4  | r1 <b>64</b>  |                |                   |               |               |                |                    | 12-F<br>874110#   |
| India                   | an Cr            | eek_       | 11464         | -                   |          |            |             |           |     | 23.5     | ********             |              | S4MAF     | <b></b> |          | MIXINU        | ı.             |                   | $\overline{}$ |               |                |                    |   |
|                         | Ouad             |            | •             | _One                |          |            |             |           |     |          | :                    | <u></u>      |           |         | ·        |               |                |                   |               |               |                |                    |   |
| . :                     |                  | :          | :             | , #10-              | <b>J</b> |            | 7           | :         |     | 98       | 32E                  |              | ٠.        |         | ANT .    |               |                |                   |               |               |                | \                  | \   |
|                         |                  | Fèceji     | 44            |                     |          |            | . 11        | CIME      |     | letales  | 44.4                 | ić           | he Ribiti | -       |          |               | L              |                   |               | <del></del> - |                |                    | \   |
| <del></del>             |                  |            | इस <b>न्द</b> |                     |          |            |             |           | -   | 12/2     |                      | -            | ٠.        | -       | $\perp$  |               | <u> </u>       |                   |               | <u>~~</u>     | <u>~</u> :     |                    |   |
| <del></del> -           | <u> </u>         | rown       | inq<br>««•••  | 91                  | _        |            |             |           |     | 841      |                      |              |           | -       | 9 rx 313 | <u>32.7</u> / | Crad           | ı-Sa•_            | 0.034         | <u>'/',</u>   | 47'-           |                    | 3131.1  |
| ٠٠٠٠                    | <u>.,ì</u>       | 85 c       | fs.           |                     |          | ፣          | *** -       |           |     | 1.6      |                      |              |           | _       | #CHY#KIF | Smal          | 1 bau          | lders             | . gra         | vels.         | and or         | obbles             | within  |
| 9***                    | 5                | 90 ç       | fs            |                     | ٠        | 1          | W+14 _      |           |     | 2.8'     |                      |              |           | _       | bar      | rrel.         |                |                   |               |               | · <del>.</del> |                    | ·   |
|                         | ļ                | CUL        |               | PIPES               |          |            | <u> </u>    |           | ·   | <u> </u> | <del>.</del>         |              | н         | EADW    |          |               | UTAT           |                   |               | · · · ·       |                |                    |   |
|                         | 12.5             | <b>0</b> · |               |                     |          | T          | \$ CC TION  | SIZE      |     | INLET    | CONTROL              | ├            | Γ .       | ·       | OUTLES   | CONTRO        | L HW           | • H1 lo           | -LSa          | lenging.      | £ .            | Γ.                 | •   |
| SIZE<br>Inches          | CCNCAE<br>BROOKS | PROJECTIV  | MITERED       | STRUCTURAL<br>PLATE | VEATICAL | MITCACD    | EXD. 8 EC   | D<br>rect |     | D<br>HA  | нж                   | Ke           | н         | قو      | 4,10     | TW            | h <sub>o</sub> | LS <sub>o</sub> - | НW            | ENTER<br>HW.  | NT ROLLI       | OUTLET<br>VELOCITY | COMMENTS  |
| Ke Conflicted -         | 0.2              | 0.9        | 0.7           | 0.7                 | 0.5      | 1.0        | 0.5         | 0         |     | <u> </u> | <del> </del>         | <del> </del> |           |         | ļ        |               | 0              |                   |               | 1             |                |                    |   |
| 12' X 7'                |                  |            |               | Х                   |          |            |             | 7         | 185 | 0.5      | 3.5                  | 0.7          | 0.5       | 2.1     | 4.6      | 1.6           | 4.6            | 1.6               | 3.5           | 0.5           | 3.5            | 9.6                | Barrel velocity   |
| 12' X 7'                |                  |            |               | Х                   |          |            |             | 7         | 590 | 1.2      | 8.4                  | 0.7          | 4.0       | 4.2     | 5.6      | 2.8           | 5.6            | 1.6               | 8.0           | 1.1           | 8.4            | 13.1               | Barrel velocity   |
|                         |                  |            |               |                     |          |            |             |           | ļ . |          |                      |              |           |         |          |               |                |                   |               |               |                |                    |   |
| -                       |                  |            |               |                     |          |            |             |           |     |          |                      |              |           |         |          |               |                |                   |               |               | . •            |                    | ····  |
|                         |                  | -          | <u> </u>      |                     |          | _          |             |           |     | · ·      |                      |              |           |         |          |               |                |                   |               |               |                | -                  |   |
|                         |                  |            |               |                     |          |            |             |           |     |          | <del></del> -        |              |           |         |          |               |                |                   |               | -             |                | <u>-</u> -         |   |
| SUMMARY .               | AND I            | ECOM       | MEND!         | L                   | L        | l <u> </u> | L <u>.</u>  | L         | L   | <u> </u> | <u> </u>             |              | <u> </u>  |         | <u> </u> | لـــا         |                |                   | <u> </u>      | !             | l              | L                  | <del></del>   |
| Q2 = 185<br>Q50 = 59    | cfs              |            | ٧b            |                     | 6 fp:    |            | @<br>@ .    |           |     |          | = 0.040)<br>= 0.040) |              |           |         |          |               | -              |                   |               |               |                |                    | %   |
|                         |                  |            |               |                     |          |            |             |           |     |          |                      |              |           |         |          |               |                |                   |               |               |                |                    |   |

| FM 34-454<br>EAco 8-848 |  |             | •       |                                  | С     | ับ      | LV               | EF        | ?T             | DE                   | SIC                  | ΝĒ             | S                | зН                                     | EET                         | _          | <u> </u> |      |                     |  |                | FEOERAL            | ARTMENT OF TRANSPORTATION MICHWAY ABENTATION? TEN VANCOUVER, WASHINGTON |
|-------------------------|--|-------------|---------|----------------------------------|-------|---------|------------------|-----------|----------------|----------------------|----------------------|----------------|------------------|--|-----------------------------|------------|----------|------|---------------------|--|----------------|--------------------|---|
|                         |  |             |         |                                  |       |         |                  |           |                | 12-G                 | (s .                 |                |                  |  |                             |            |          |      |                     |  |                | _                  | 12-G  |
| Gran                    | ite C  | <u>reek</u> | STALAN  | ***                              |       |         |                  |           |                | 11.4                 | <del>Likių 1</del> 1 |                | . 11 144 (       | mee                                    | freat                       | MIKIKU:    | <b>u</b> |      | /                   |  |                |                    |   |
| 1                       | Quad   |             |         |                                  |       |         |                  |           |                | <u> </u>             | :                    | •              |                  | _[                                     |                             |            |          |      |                     |  |                |                    |   |
|                         | ··   | LOCATI      |         |                                  |       |         | 17               | C1 100 W  |                | 85                   | 31E                  |                | in ( Ocht 4)     | _{                                     | AHİY -                      | <u>.</u> _ |          |      |                     |  |                | \                  |   |
|                         |  |             |         |                                  |       |         |                  |           |                | 441                  |                      |                |                  |  |                             |            |          |      |                     | ~~   |                |                    | <u> </u>  |
| <u>-</u>                |  | rown        |         |                                  |       |         |                  |           |                | 11/1                 | 0/88                 |                | ·                | _                                      | <u>1</u><br>n <u>rx 297</u> | 1.4 /      |          |      | 0.012               | <u>'/</u> '                                  | 74°            | <u> </u>           |   |
| 9-9                     | 7  |             |         | •                                |       | _ 1     | ι <b>₩</b> ·> '- | _         |                | 1.2'                 |                      |                |                  |  |                             | •,         |          |      |                     |  |                | bles               | within 2970.5   |
| Q+1+                    | 2  | 90 ç        | fs _    |                                  |       | 1       | -                |           |                | 2.3'                 |                      |                |                  | _                                      | bac                         |            |          |      |                     |  |                | ·                  | ·   |
|                         |  | CUL         | VERI    | DES<br>PIPC                      | CRIP  | TION    |                  | Ţ <u></u> |                |                      |                      | T              | н                | EADW                                   |                             |            | TATU     |      | · · · · · ·         | <u>.                                    </u> | · · · · ·      |                    | ·   |
| SIZE                    | CONCRETE<br>## # # # # # # # # # # # # # # # # # # | PROJECTING  | TERED   | STRUCTURAL<br>PLATE<br>(witches) | TICAL | MITERED | \$ ECT104        | SIZE      | ٥              | HW                   | CONTROL              | K <sub>e</sub> | н                | d <sub>c</sub>                         | 4c+0                        | TW         |          | LSo  | - L. S <sub>0</sub> | HW.  | ).<br>L.L.1340 | OUTLET<br>VELOCITY | соммента  |
| INCHES                  |  | 0.9         | 0.7     | 0.7                              | 0.5   | ,       | ġ.<br>0.5        | rttt      |                | D                    | ,                    | ~              | "                |  | 2.                          |            |          | L-30 |                     | D .  | 2 X            | VELO               |   |
| 12.8' X                 | 1  |             |         |                                  |       | Х       |                  | 7         | 75             | 0.4                  | 2.8                  | 0.7            | 0.2              | 0.7                                    | 3.9                         | 1.2        | 3.9      | 0.9  | 3.2                 |  | i              | l i                | Barrel velocity   |
| 12.8' X                 |  |             |         |                                  |       | х       |                  | 7         | 290            | 0.7                  | 4.9                  | 0.7            | 1.4              | 2.8                                    | 4.9                         | 2.3        | 4.9      | 0.9  | 5.4                 | 0.8  | 5.4            | 7.2                | Barrel velocity   |
|                         |  |             |         |                                  |       |         |                  |           |                |                      |                      |                |                  |  |                             |            |          |      |                     |  |                |                    | •   |
|                         |  |             |         |                                  |       |         |                  |           |                |                      |                      |                |                  |  |                             |            |          |      |                     |  | <u> </u>       |                    |   |
| <del></del>             |  |             |         |                                  |       |         |                  |           |                |                      |                      |                |                  |  |                             |            |          |      |                     | <u> </u>                                     |                |                    |   |
|                         |  |             | _       |                                  | -     | -       |                  |           |                |                      | i                    |                |                  |  |                             |            |          |      | <del></del>         |  |                | -                  |   |
| SUMMARY                 | AND R  | ECOM        | MENDA   | LTIONS                           | t     | L       | <u> </u>         | .         |                | I                    | l                    | <b>.</b>       | L                |  | <u> </u>                    | !          | L        |      |                     | <u>.                                    </u> | l              | <u> </u>           | <del></del>   |
| Q2 = 75<br>Q50 = 25     |  |             |         |                                  |       |         | ()<br>()         | qp =      | 1.8 t<br>3.7 t | ft. (n =<br>ft. (n = | 0.040)<br>0.040)     | culve<br>culve | rt bai<br>rt bai | rrel<br>rrel                           |                             |            |          |      |                     |  |                |                    | :   |
|                         |  |             |         |                                  |       |         |                  |           |                |                      |                      |                | ,                |  |                             |            |          |      |                     |  |                |                    |   |
| O HI CHITE              | C ALLACT   |             | helma P | P(\$ -                           | - 01  | ×1:11   | B tutt           | 53        | 0 lo 1         | in Beatt             | M.                   |                |                  | ······································ |                             |            |          |      |                     |  |                |                    |   |

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| FM 40 - 28 4<br>Cher 0 - 78 5 |                                      |             | ,       |                | C            | Ü           | LV   | EF  | 21     | DE                   | SIC           | ξŅ            | 8       | Н       | EET                            | <u>Γ</u> .    |            | ·                  |                  |            |                    | US DEP             | ARTMENT OF TRANSPORTATION:<br>L RIGHMAY ADMINISTRATION:<br>TEN YANCOUVER, WASHINGTO |
|-------------------------------|--------------------------------------|-------------|---------|----------------|--------------|-------------|--|---|--------|----------------------|---------------|---------------|---------|---------|--------------------------------|---------------|------------|--------------------|------------------|------------|--------------------|--------------------|---|
|                               | -                                    |             |         |                |              | •           |  |   |        | 12-h                 |               |               | · ·     |         | FLEYA                          | r             |            | ,                  |                  |            |                    |                    | 12-11<br>TATION   |
| Gra                           | nite (                               | neek        | 11211   | ***            |              |             |  |   |        | 11.4                 | 145H46( AR    | 14            | . 14444 | <b></b> |                                | RINIRGI<br>() | ¥          |                    | $\overline{}$    |            |                    |                    |   |
| USGS                          | Quac                                 |             |         |                |              | ı<br>       |  |   |        |                      | :             | •             |         |         |                                |               |            |                    | <b>/</b>         | •          |                    |                    |   |
|                               |                                      |             | :       | ***            |              |             | 17   | 7   |        | <b>8</b> \$          | 31E           |               | •       | .       | AH)W =                         |               |            |                    |                  |            | •                  | \                  | \   |
|                               |                                      | LOCATI      |         | •              |              |             |  | 44113   |        | terring              | <b>#</b> 4.54 |               | ME BINA | -       | İ                              |               | 1          | <u> </u>           |                  |            |                    |                    | \   |
|                               |                                      |             | 1itata  |                |              | <del></del> |  |   |        | 841                  |               |               |         | -       | <u></u>                        | <del></del>   | <u>/_</u>  |                    | _ ^              | ~~         | ~                  |                    |   |
|                               | B                                    | rown        | ing_    | <del>(1</del>  |              |             |  |   |        | 11/1                 | 0/88          |               |         | -       | are 2990                       | <u>0.0,</u> / | j.<br>Grad | -so                | 0.015            | <u> Z'</u> | 72'-               |                    | nr 2988.9   |
| a•5 —                         | . 7                                  | 5 cf        | s       |                |              | _ ı         | ' <b>**</b> 2 '-                                 |   |        | 1.2'                 |               |               |         | _       | #ۖYKK#F                        | _Smal         | 1 bou      | lders.             | _grav            | æls. a     | and co             | Habbles            | within  |
| Q-11                          | 2                                    | 90 ç        | fs      |                |              | 1           | [¥***  |   |        | 2,2'                 |               |               |         | _       | the                            | barre         | 1,         |                    |                  |            |                    |                    | ·   |
| <del></del>                   |                                      |             | VERT    | DES            | Č010         | TION        |  | 1   | ,      |                      |               |               | н       | EADW    |                                |               | UTAT       |                    |                  |            |                    |                    | ·   |
|                               | 1.55                                 | THO         | Ê       | 3              | ير ا         | 8           | Į į  | SIZE  |        | INLET                | CONTROL       | -             |         |         | OUILET                         | CONTRO<br>I   | L KW       | • K t ha           | -LS <sub>o</sub> | 111111     | \$                 |                    |   |
| SIZE<br>INCHES                | CONCRETE<br>BROOVE-END<br>PROJECTIVE | PROJECTING  | MITERED | STRUCTURAL SE  | VERTIC.      | MITER       | END SECTION                                      | D<br>rtts   | ٩      | H.M.                 | HW            | K,            | н       | ط       | <u>d</u> <sub>c</sub> +0<br>2· | TW            | ho         | L\$ <sub>o</sub> * | ·KW              | <u>н</u> ж | CDMT ROLLING<br>KW | OUTLET<br>VELOCITY | сомиентя  |
| Ke Coolikiool-                | 0.2                                  | 0.9         | 0.7     | 0.7            | 0.5          | 0.7         | 0.5  | 0   |        | <u> </u>             | ļ             |               |         |         |                                |               | 0          |                    |                  | <u> </u> : | 8                  | -                  | ·   |
| 13.1')                        | 7.6'                                 |             |         |                |              | X           |  | 7.6   | 75     | 0.3                  | 2.3           | 0.7           | 0.2     | 0.9     | 4.3                            | 1.2           | 4.3        | 1.1                | 3.4              | 0.4        | 3.4                | 4.7                | Barrel velocity   |
| 13.1' >                       | 7.6                                  |             |         |                |              | x           |  | 7.6'  | 290    | 0.6                  | 4.6           | 0.7           | 0,8     | 2.7     | 5.2                            | 2.2           | 5.2        | 1.1                | 4.9              | 0.6        | 4.9                | 7.1                | Barrel velocity   |
|                               |                                      |             |         |                | <del> </del> |             |  |   | -      |                      | <u> </u>      | 1             |         |         | <u> </u>                       |               |            |                    |                  |            |                    |                    |   |
|                               |                                      |             |         | _              |              |             |  | -   |        |                      |               | <b> </b>      |         | -       | <u> </u>                       | ļ             |            |                    | ~                | <b> </b>   |                    |                    |   |
|                               |                                      |             |         |                | <u> </u>     |             |  |   |        |                      |               |               |         |         |                                |               |            |                    | i<br>            |            |                    |                    |   |
|                               |                                      |             |         |                |              |             |  |   |        |                      |               |               |         |         |                                |               |            |                    |                  |            |                    |                    |   |
|                               |                                      |             |         |                |              |             | <del>                                     </del> | <del>                                      </del> |        | <u> </u>             | <del></del>   | <del></del> - |         |         |                                |               |            | ·                  | <u>-</u> _       |            |                    |                    |   |
| \$UMWARY                      |                                      |             | HERU.   | TICE           |              | <u> </u>    |  | <u> </u>  |        | l                    |               |               |         |         | <u> </u>                       |               |            |                    |                  | <u> </u>   |                    |                    | •   |
| Q2 = 75<br>Q50 = 29           | çfs                                  |             | ٧b      | = 4.1<br>= 7.1 | 7 fp         |             | @<br>@ .   |   |        | ft. (n =<br>ft. (n = |               |               |         |         |                                |               |            |                    |                  | ,          |                    |                    |   |
|                               |                                      |             |         |                |              |             |  |   |        |                      |               |               |         |         |                                |               |            |                    |                  |            |                    |                    |   |
| O ISI CHILI                   | T DIIIET                             | ,<br>() (4) | liki i  | <b>41</b> -    | 01           | et it       | B Witt   | 11,   | O No N | tat writti           | <u> </u>      |               |         | •       | •                              |               |            |                    |                  | ·          |                    |                    |   |
| ist ust i                     | ixensidî                             | ler tr      | CE COLT | (111           | Ť.           | (#( 64      |  |   | fri l  | 111 16 ····          |               |               |         |         |                                |               |            |                    |                  |            | •                  |                    |   |
|                               |                                      |             |         |                |              |             |  |   |        |                      |               |               |         |         |                                |               |            |                    |                  |            |                    |                    |   |

| fm ee - (1 a<br>ma- m -   E             |                                      |              |           | <u>.</u>            | C             | Ü       | LV             | EF                | ?T            | DE                   | SIC              | ЭŅ             | <br>S            | SHE            | EET  | Γ .            |           |       |        | -        |                   | PEDERAL            | ARTHENT OF TRANSPORTATION RIGHWAY ADMINISTRATION TEN VANCOUVER, WASHING |
|---|--------------------------------------|--------------|-----------|---------------------|---------------|---------|----------------|-------------------|---------------|----------------------|------------------|----------------|------------------|----------------|--|----------------|-----------|-------|--------|----------|-------------------|--------------------|---|
| Cuan                                    | ito (                                | · · ·        | 6.F(21    | NA-E                | -             | ,       |                | · ·               |               | 12-1<br>14.5         | (a .             |                |                  | -              | trava  | ties<br>Minimu |           |       |        |          |                   |                    | 12-I<br>374164  |
| Gran                                    | ive c                                | , een        | 1145¢#    | LAME O              |               |         |                |                   |               | 11.5                 |                  |                | . Idwat          |                | +  |                |           |       |        |          |                   |                    |   |
|   | Quac                                 | <u> </u>     | uare.     | <u>Ore</u>          | gon_          |         | 3(             | <del></del>       |               | <br>8\$              | 30E              | <del></del>    | · ,              |                | AH#*.  |                |           |       |        |          |                   |                    |   |
|   | •                                    | 406411       | <b>64</b> |                     | <del></del> - |         |                | CTHON             | <del></del> : | Tiesiae              | ALI              |                | MERIMA           | <u>-</u> -     |  |                | 1         |       | _      |          |                   |                    | \   |
|   |                                      | • •          | *****     |                     |               |         | <del></del>    |                   |               | 111                  |                  |                |                  |                |  |                | <u>/.</u> |       |        | ~~~      | _                 |                    |   |
|   | B                                    | mwn          | ing -     | <b>B</b> T          |               |         |                |                   |               | PA10                 |                  |                |                  | $- \cdot$      | <u> 228</u>                                      | 1.4.           | C-44      | -sQ   | 0221   | /¹ , t•. | 111               |                    | 3279  |
| ٠٠٠ ٢٠٠                                 | , 9                                  | <u> 5 cf</u> | S         |                     |               | ¹       | . g**          |                   |               | 2.2'                 |                  |                |                  | <u> </u>       | ¥£ÁT¥K#  | Smal           | 1_bou     | lders | . grav | æls. a   | and co            | <u>obbles</u>      | within  |
| Q-3+                                    | 3                                    | 50 c         | fs        |                     | · ·           | ¹       | T¥*H _         |                   | <del></del>   | 4,2'                 |                  |                |                  | _              | the  | barre          | 1         | · .   |        |          | ·                 |                    | ·<br>·  |
|   | <u> </u>                             | 4/67         | 1.        | PIPC                | 647.45        | च्यार   | z              |                   |               | 191.53               | CONTROL          | T              | Н                | EADWA          |  | COMP           | TATU      |       | •1 S - |          |                   |                    |   |
| SIZE<br>INCHES                          | CONCALTE<br>ENDOVE-EXD<br>PROJECTING | PROJECTIVE   |           | STRUCTURAL<br>PLATE | VERTICAL      | MITERED | END SECTION    | SIZE<br>D<br>rccr | a             | KW<br>D              | HW               | K.             | н                | d <sub>e</sub> |  | TW             |           |       |        | HW.      | CONTROLLING<br>NW | OUTLET<br>VELOCITY | COMMENTS  |
| Corlliciant                             | 0.2                                  | 0.3          | 0.7       | 0.1                 | 0:5           | 0.1     | 0.5            | 0                 |               | <u> </u>             | <u> </u>         |                |                  |                | <del>                                     </del> | •              |           |       |        |          |                   |                    |   |
| 13.2' X                                 | 111'                                 |              | <u> </u>  | <u> </u>            | ļ             | X       | <u> </u>       | 11                | 95            | 0.2                  | 2.2              | 0.7            | 0.1              | 1.0            | 6.0  | 2.2            | 6.0       | 2.4   | 3.7    | 0.3      | 3.7               | 6.2                | Barrel velocit  |
| 13.2' X                                 | 11'                                  |              |           | _                   | _             | X       |                | 11                | 350           | 0.5                  | 5.5              | 0.7            | 0.6              | 4.0            | 7.5  | 4.2            | 7.5       | 2.4   | 5.7    | 0.5      | 5.7               | 9,0                | Barrel velocit  |
|   |                                      |              |           |                     | _             |         |                |                   |               | <u> </u>             |                  |                |                  |                |  |                |           |       |        |          |                   |                    |   |
|   |                                      |              |           |                     |               |         |                |                   |               |                      |                  |                |                  |                |  |                |           |       |        |          | -                 |                    |   |
|   |                                      |              |           |                     |               |         |                |                   |               |                      |                  |                |                  |                |  |                |           |       |        |          |                   |                    |   |
|   |                                      |              |           |                     |               |         |                |                   |               |                      |                  |                |                  |                |  |                |           | -     |        |          |                   |                    |   |
| <del>имилят</del><br>Q2 = 95<br>Q5O = 3 | cfs                                  |              | ٧b        | <b>=</b> 6.         | 2 fp          | S<br>S  | @              | db =<br>db =      | 2.4<br>4.6    | ft. (n =<br>ft. (n = | 0.045)<br>0.045) | culve<br>culve | ert ba<br>ert ba | rrel<br>rrel   | <u> </u>   |                |           | l J   |        |          | L <u>. —</u>      | 1 <u></u> I        |   |
|   |                                      |              |           |                     |               |         |                |                   |               |                      |                  |                |                  |                |  |                |           |       |        |          |                   |                    |   |
| est twister                             |                                      |              |           |                     | 01            | KIT IT  | 13 1 to 11 (1) | 11,               | O ho is i     | lat datratta         | tí               |                |                  |                |  |                |           |       |        |          | <del></del>       | <del>.</del>       | <del></del>   |

| fn 36 - 114<br>(Ato 8 - 114 |                                      |         |                  |                  | 0        | UI         | LV           | EF   | ₹ <b>Т</b>           | DE                 | SIC               | ЭŅ                                      | S                | H            | EET            |              |              |                   |               |                |                | FEDERAL                                      | RIVERT OF TRANSPORTATION<br>NIGHWAY ADMINISTRATION:<br>TEN YANCOUVER, WASHINGTO |
|-----------------------------|--------------------------------------|---------|------------------|------------------|----------|------------|--------------|--|----------------------|--------------------|-------------------|---|------------------|--------------|----------------|--------------|--------------|-------------------|---------------|----------------|----------------|--|---|
|                             |                                      |         | ilici s          | 1.1              |          |            |              | <u>.                                    </u> |                      | 12-J               |                   |   | -                | <u>.</u>     |                |              |              |                   |               |                |                | _  | 12-1  |
| Sunf]                       | lower.                               |         |                  |                  |          |            |              |  |                      | 22,6               |                   | <del></del>                             | . 54948E I       |              | I.             | MINING.      | ĸ            |                   | _             |                |                | \  |   |
| USGS                        |                                      |         |                  |                  |          | on"        |              |  |                      |                    | :                 |   |                  |              |                |              |              |                   |               | •              |                |  |   |
|                             |                                      | LOCATIO | *-               |                  |          |            | 19           | (1108  |                      |                    | 27E               |   | •                | _}           | AXX            |              |              |                   |               |                | •              | \  | \   |
| · · · · · ·                 |                                      |         | risata           |                  |          |            | **           | C) 10 H                                      | •                    | . 148454#          | A44               | • | hi ( hidean      |              |                |              | -            |                   |               |                |                |  | <u></u>   |
|                             |                                      |         | ng               |                  |          |            |              |  |                      | 11/10              | /88               |   |                  |              | 4.ex 366]      | 5 /          | <del>/</del> | <del></del> -     | 3 037         | / <u>'</u>     | 871            | <u>.                                    </u> |   |
| ۰-2-                        |                                      |         |                  |                  |          | τ          | ₩*o '        |  |                      | 1.1'               |                   |   |                  | 1            |                | ٠,           |              |                   |               |                |                |  | ls. and   |
| 9-11_                       |                                      | 35 cf   |                  |                  |          | _ ·<br>_ • | -            |  |                      | 2.1'               |                   |   |                  | _            | •              |              |              |                   |               |                |                |  |   |
|                             |                                      | CUL     | VERT             | DES              | CRID     | TION       |              | Ţ  |                      |                    | -                 |   | H                | EADW.        |                |              | PUTAT        |                   |               |                |                |  |   |
|                             | TTE<br>THE                           | DHALL   | <u>د</u><br>ق    | 3 2              | =        | g          | £110¥        | SIZE   |                      | INCET              | CONTROL           |   | · · ·            |              | OUTLET         | CORTRO       | OL HW        | - HINO            | - <u>L5</u> @ | antitt         | <u> </u>       |  | •   |
| SIZE<br>INCHES              | CCHCRETE<br>BROOVE-END<br>PROJECTING | PROJEC  | WITER            | STAUCTI<br>PLATE | VERTIC   | HITE       | END- SECTION | PCET   | Q                    | р<br>НЖ            | НW                | K.                                      | н                | فر           | 4,10           | TW           | }            | LS <sub>o</sub> ' | ·HW           | HW.            | CONTROLLING    | OUTLET                                       | СОЙМЕНТЯ  |
| Ke Coefficient -            | 0.2                                  | 0.9     | 1,0              | 7.0              | 0.5      | 0.1        | 0.5          | 0  | <del> </del>         |                    | <u> </u>          |   |                  |              | <del> </del>   | •            | -            |                   | _             | -              | 8              |  |   |
| <u>17,3' Sr</u>             | en X                                 | 10'     | rise             | <u>with</u>      | 12"      | hig        | baf          | Пе   | <b> </b>             | <u> </u>           | <u> </u>          |   |                  |              | <u> </u>       |              |              |                   | <u> </u>      | ļ              | <del> </del> — |  |   |
| <u>Equivale</u>             | nt 17                                | .3'     | X 9'             |                  | <u> </u> |            |              | ļ  | <u> </u>             | ļ                  |                   | <u> </u>                                |                  |              | <u> </u>       |              |              | ļ                 |               | ļ              | ļ <del>_</del> |  | <u> </u>  |
|                             |                                      |         |                  |                  |          | χ          |              | 9  | 135                  | 0.3                | 2.7               | 0.7                                     | 0.2              | 1.6          | 5.3            | 1.1          | 5.3          | 3.2               | 2.3           | 0.3            | 2.7            | 7.0  | Barrel velocity   |
|                             |                                      |         |                  |                  |          | χ          |              | 9  | 485                  | 0.6                | 5.4               | 0.7                                     | 1.0              | 3,2          | 6.1            | 2.1          | 6.1          | 3.2               | 3.9.          | 0.4            | 5.4            | .10,8  | Barrel velocity   |
|                             |                                      |         |                  |                  | T        |            |              |  |                      |                    |                   |   |                  |              | <del> </del>   |              |              |                   |               |                | <u> </u>       |  |   |
|                             |                                      |         |                  |                  | -        |            |              | <del> </del>                                 |                      |                    |                   |   |                  |              | <del> </del> - | <del> </del> |              | <del></del>       | <u> </u>      | <del> </del> _ | <b></b>        |  |   |
| SUMMARY .                   | AND #                                | ECOM    | LENDA            | TIONS            | <u> </u> |            | l            | <u> </u>                                     | <u> </u>             | <u> </u>           |                   | l                                       |                  |              | 1              |              | <u> </u>     | <u> </u>          |               |                | <u> </u>       |  | · · · · · · · · · · · · · · · · · · ·   |
| Q2 = 139<br>Q50 = 48        |                                      |         |                  | _                |          | fps<br>fns | ,            | @<br>@                                       | <b>q</b> р =<br>qр = | 1.7 ft.<br>3,4 ft. | (n = 0) $(n = 0)$ | .045)<br>.045)                          | culver<br>culver | t ba<br>t ba | rrel<br>rrel   |              | •            |                   |               |                |                |  | •.  |
| 400 T                       | . UI.                                | •       |                  |                  | , ,,,    | . 193      |              | -  | _                    |                    | , -               | •                                       |                  |              |                |              |              |                   |               |                |                |  |   |
| 0 111 (1116                 | 1 PIGE(1                             | (114    | labet fi         | rts              |          |            | B run        |  | Q No fi              | fat fateift        | ŧí                |   |                  |              | .•             | <del></del>  |              |                   |               |                |                |  | · · · · · · · · · · · · · · · · · · ·   |
| ist list'i                  |                                      | f44 11  | (# <b>C</b> 014) |                  |          |            |              | •  | WIT                  | , 111 11           |                   |   |                  |              |                |              |              |                   |               |                | •              |  |   |

. . .

| f N 14 - 119<br>(Nys. N - 32)                                  | CULVE   | RT          | DESIG                          | ЭŅ             | S         | 1-18    | EET              | -      |                |                   |                    | •        |                   | US DEPARENCE REGION | ARBWENT OF TRANSPORTATION,<br>HIENWAY ADMINISTRATION?<br>YEK VANCOUVER, WASHINGTON |
|--|---|-------------|--------------------------------|----------------|-----------|---------|------------------|--------|----------------|-------------------|--------------------|----------|-------------------|---------------------|--|
| PADILET  | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,                        |             | 11-A                           |                | · ·       |         | ELEVAT           |        |                |                   |                    |          | •                 | _                   | 11-A   |
| Marks Creek  |   |             | 29.1                           |                | -         | P4. E 1 | -,               | RIKIMU | •              |                   |                    |          |                   | \                   |  |
| USGS Quad ~ "Looko   | rt Mountain"  |             | ;                              |                |           |         |                  |        |                | _/                | <b>/</b>           |          |                   |                     |  |
|  | 17  |             | 13S 19E                        |                |           | _[      | <br>             |        |                |                   |                    |          |                   | /                   | \  |
| LOCATION   | 5127199   | , 14        | 74187 444                      |                | #£ #13+14 |         |                  |        | 7              | ,<br>             |                    |          |                   |                     | \  |
| - SERVICE  | <del></del>   |             | 8416                           |                | ·         | -       | 1_               |        | <u> </u>       |                   | _                  | ~~~      | _                 |                     |  |
| Browning Execute   | BY  | <del></del> | 11/10/88                       |                |           |         | e <u>rv. 379</u> | 5.4    | r<br>Grade     | -5+ • <u>_</u>    | 0.002              | 7'ــــر٠ | 531               | <del></del>         |  |
| 9.2115 cfs   | Z.w.f   | <u> </u>    | 1.7'                           | <del></del>    |           |         | ¥€ñY&X1:-        | Grave  | els an         | d cob             | bles               | locate   | d wit             | hin th              | e <u>nrv 3796, 3</u>   |
| 9*** 600 cfs   | TW-se   |             | 3.7'                           |                |           | _       | culv             |        |                |                   |                    |          |                   |                     | · <u> </u>   |
| CULVERT  | DESCRIPTION   |             |                                |                | н         | ADW.    |                  |        | UTAT           |                   |                    |          |                   |                     |  |
|  | PIPE PEADWALLS  | ε -         | INTEL CONTROL                  | <del> </del> - |           |         | OUTLET           | CONTRO | L RW           | Hibo              | -LS <sub>e</sub> _ | 1        | <b>5</b> .        |                     |  |
| SIZE STORY STORY   | STAUCTURAL<br>PACTICAL<br>VENTICAL<br>MITERED<br>END. SECTION |             | нм нм                          | K <sub>4</sub> | н         | 4,      | dc+D             | TW     | h <sub>e</sub> | LS <sub>o</sub> . | ∙н₩                | HW.      | CONTROLLING<br>HW | OUTLET<br>VELOCITY  | сомментѕ   |
| Ka Cantilicians 0.2 0.9 0.7                                    | 0.7 0.5 0.1 0.5 0   |             |                                |                |           |         | <b> </b>         | •      | 0              |                   |                    |          | 8_                |                     | <u>:</u>   |
| 18' X 8.8'   | х 8.8   | 115 0       | .2 1.8                         | 0.7            | 0.1       | 0.9     | 4.9              | 1.7    | 4.9            | 0.1               | 4.9                | 0.6      | 4.9               | 3.0                 | Barrel Velocity  |
| 18' X 8.8'   | x 8.8   | 600 0       | .7 6.2                         | 0.7            | 1.0       | 3.5     | 6.2              | 3.7    | 6.2            | 0.1               | 7.1                | 0.8      | 7.1               | 4.8                 | Barrel Velocity  |
|  |   |             |                                |                |           |         |                  |        |                |                   |                    | -        |                   |                     |  |
|  |   |             |                                | _              |           |         |                  |        |                |                   | <del></del>        |          | <u> </u>          | <u> </u>            |  |
|  |   |             |                                |                |           |         |                  |        |                |                   |                    |          |                   | ·                   |  |
|  |   | 1 1         |                                |                |           |         |                  |        |                |                   |                    |          |                   |                     |  |
|  |   | _  -        |                                |                |           |         |                  |        |                |                   | _                  | <u> </u> |                   | <del>-</del> -      |  |
| SUMMARY AND RECOUNSED  | TIONS   |             | <u> </u>                       |                |           |         |                  |        |                |                   |                    | l        |                   |                     | <del></del>  |
| For Q2 = 115 Cfs For Q50 = 600 cfs                             | Vb = 3.0 fps @ Vb = 4.8 fps @                                 |             | 6 ft. (n = 0.<br>8 ft. (n = 0. |                |           |         |                  |        |                |                   |                    |          |                   |                     |  |
| 101 Q30 - 000 C1S  | 10 - 4.0 ips @  | (ii) – 0.   | O 16. (II - 0,                 | J-10)          | 101 U     | e cu    | ,                |        |                |                   |                    | •        |                   |                     |  |
|  |   |             |                                |                |           |         |                  |        |                |                   |                    |          |                   |                     |  |
| <u> </u>   |   |             |                                | .,             |           |         |                  |        |                |                   |                    |          |                   |                     |  |
| O BEL CHITCH SHEETER SON BOWN FO<br>BEL LISE SHEETERS SON COLT | MS - DIMEN IN STREET, (1255 LEME COLUMN MAIN                  | - 111 H     | ertrift at                     |                |           |         |                  |        |                |                   |                    |          |                   |                     |  |

| fn 10-110<br>(44, 4-14)                            |                             |            | 0  | U          | LV               | EF                | ?T               | DE                 | SIC                | ξŅ           | S         | 1-18  | EET             |                                       |                | ·                 |          |   |             | FEDERAL      | ATHERT OF TRANSPORTATION HISHWAY ADMINISTRATION (EM VARCOUVER, BASHINGT |
|--|-----------------------------|------------|--|------------|------------------|-------------------|------------------|--------------------|--------------------|--------------|-----------|-------|-----------------|---------------------------------------|----------------|-------------------|----------|---|-------------|--------------|---|
| Brown's Cree                                       | <del>- raoner -</del><br>ek |            |  | •          |                  | <u>·</u>          |                  | 10-A<br>24.7       |                    |              | I SWAC I  |       | sream           | MINIMU                                | 1              |                   |          |   |             | _            | 10-A<br>STATION   |
| USGS Quad -  | 11-640                      | h t wt     |  |            | 29               |                   |                  | 215                | 8E                 | ·            | <u></u>   |       | AKW             |                                       |                | _/                |          |   |             |              |   |
|  | CATING<br>BESTERE           |            |  |            |                  | CIMA              |                  | 1044044            | RANG               |              | ME BIPLAN | _     |                 |                                       | F              |                   |          | <del>~~</del>                                 |             | <del>-</del> |   |
| Brow   | wning<br>crecess<br>cfs     | H-         |  |            | Wan '            |                   | <del></del>      | 1.8'               | /88                | <del></del>  |           | -     | a <u>rk 433</u> |                                       |                |                   |          |   |             |              | ner 4332.3  |
| 415  | cfs                         |            | -  | •          | **** <u>-</u>    | ·                 |                  | 3.6'               |                    |              |           |       | with            | in the                                | culv           | ert b             |          |   | vei di      | ET_E00       |   |
|  | ULVERT<br>HETAL             | PIPE       | FEAD   | WÁLĽŠ      | ž                |                   |                  | IKLET              | COXTAGE            | <u> </u>     |           | EADW. | ATER<br>OUTLET  |                                       | L HW           |                   | -LSo     | •   |             |              | ,   |
|  | MITERED 40                  | STRUCTURAL |  | - KITERED  | END. SECTION     | SIZE<br>D<br>rttt | ٥                | HW<br>O            | нw                 | к,           | н         | €c    | dr. +0          | TW                                    | h <sub>o</sub> | LS <sub>o</sub> . | ·HW      | HW.<br>O                                      | CONTROLLING | OUTLET       | COMMENTS  |
| 2.6' X 9.4' set                                    |                             |            |  |            | i                |                   | strea            | bed.               |                    |              |           |       |                 |                                       |                |                   |          |   |             |              |   |
| se equivalent                                      | 12.5' X                     | 8.0        | <u>.                                    </u> |            | <u> </u>         |                   |                  | J                  | <u> </u>           |              |           |       |                 |                                       |                |                   |          | <u>                                      </u> | <u> </u>    |              |   |
|  |                             |            |  | X          |                  | 8                 | 100              | 0.3                | 2.4                | .7           | 0.2       | 1.6   | 4.8             | 1.8                                   | 4.8            | 0.4               | 4.6      | 0.6   | 4.6         | 4.2          | Barrel Velocity   |
|  | _                           |            |  | X          |                  | 8                 | 415              | 8.0                | 6.4                | .7           | 1.4       | 3,5   | 5.7             | 3.6                                   | 5.7            | 0.4               | 6.7      | 8.0   | 6.7         | 6.1          | Barrel Velocity   |
|  |                             |            |  |            |                  |                   |                  |                    |                    |              |           |       |                 |                                       |                |                   |          |   | -           |              | <u> </u>  |
| summary and Record Q2 = 100 cfs<br>or Q50 = 415 cf | S<br>fs                     | Vb =       | 4.2<br>6.1                                   | fps<br>fps |                  | @<br>@            | db = 2<br>db = 6 | 2.4 ft.<br>5.4 ft. | (n = 0.<br>(n = 0. | 035)<br>035) | for th    | e cui | vert ba         | irrel.                                |                | <u> </u>          | <u> </u> |   | <b>4</b>    |              |   |
| ·  |                             |            |  |            |                  |                   |                  |                    |                    |              |           |       |                 |                                       |                |                   |          |   |             |              |   |
| O ste teletet ejuertice<br>est bisk biskasibs fo   | Jet tober F<br>2 Atta Cete  | V(1)       |  |            | g runt<br>Iti ku | ",                | o ho m i         | 14 (2411)          | 61                 |              |           | •     |                 | · · · · · · · · · · · · · · · · · · · | · · · · · ·    |                   |          |   |             |              |   |

| 78 M -   14<br>(8 - 8 -   15) |               |      |             |         |                     | C            | U       | LV        | EF       | ?T       | DE              | SIC       | ξŅ          | 8          | зН         | EET            | _       | ••       | •             |              |                |                  | PEDERAL            | ARIMENT OF TRANSPORTATION<br>, HIGHWAY ADMINISTRATION:<br>TER VANCOUVER, WASHINGTO |
|-------------------------------|---------------|------|-------------|---------|---------------------|--------------|---------|-----------|----------|----------|-----------------|-----------|-------------|------------|------------|----------------|---------|----------|---------------|--------------|----------------|------------------|--------------------|--|
|                               |               |      | 7.0         | मस -    | *151                |              |         |           | :        |          | 2-A             |           |             |            | _          | <b>61641</b> 7 |         |          |               |              |                |                  | _                  | 2-A<br>************************************  |
| Lon                           | ne Cn         | ek   |             |         | RADE                |              |         |           |          |          | 6.8             | 11116 14  |             | Idwat      |            | ~ —            | RINIMA  | <b>K</b> |               |              |                |                  | \                  |  |
| USG                           | s Qu          | ad · |             |         | enbus               |              | ot Sp   | rings     | , Ore    | gon"     |                 | ;         |             |            |            |                |         |          |               | /            |                |                  |                    |  |
|                               |               |      |             |         | **                  |              |         | 24        |          |          | 7S <sup>′</sup> | 7E        |             |            | _          | AH)# = _       |         | ····     |               |              |                |                  |                    |  |
|                               | <u>-</u> -    | •    | • C 4 1 1 0 | 4       |                     | <del>-</del> |         | 11        | (1164    |          | Teasiar -       | *4**      |             | 11 ( E1)+A | <u>-</u> 1 | Ì              |         |          |               |              |                |                  |                    |  |
|                               |               |      | <u>-</u>    | HALL    |                     |              |         |           |          |          |                 |           |             |            |            |                |         |          |               |              | ~~             |                  |                    |  |
|                               |               |      | owni        | ng      |                     |              |         |           |          |          | 11/10           | 2/88      |             |            | _ [        | acv 347        | · · · · | ·/       | <del></del> - | 0.050        | ١ <u>//'</u> ر | יני <del>ר</del> |                    |  |
|                               |               | AAC  | cre<br>O cf | C#40    | BY                  |              |         |           |          |          | 2.6'            |           | _           |            | _          |                | ,       |          |               |              |                |                  | •                  | n. 3476.3  |
| ۰۰ ک <sub>۰۰</sub> ۵          | · ·           |      |             |         |                     |              | _ '     | . 5       |          |          |                 |           |             |            | 一门         | ¥£Ř¥¥X¶:™      |         |          |               |              |                |                  | s are              |  |
| Q-++_                         |               | 116  | 50 c        | fs      |                     | •            | ¹       |           |          |          | 3.9'            |           |             |            | _          | <u>loc</u>     | ated    | throu    | <u>qhout</u>  | the l        | parrel.        |                  |                    |  |
|                               |               |      | CUL         |         | DES                 |              |         | 1 _       | Ţ        |          |                 |           | · · · · · · | н          | EADW       |                |         | PUTAT    |               |              |                | ,                |                    |  |
|                               | 12.5          | ž    | ž į         |         |                     | *            |         | \$ CT 10# | SIZE     |          | _INLET_         | CONTROL   | <b> </b>    |            | !          | OUTLET         | CONTR   | IL HW    | • H 1 1/10    | - <u>L5.</u> | entitt         | ₽.               |                    |  |
| SIZE                          | CONCRE        |      | É           | MITERED | STRUCTURAL<br>PLATE | VERTICAL     | MITERED | Z8 -QH2   | PEET     | <b>Q</b> | ₽<br>K₩         | нw        | к.          | н          | đ,         | 4,10           | τw      | h,       | L\$o          | ·HW          | HW.            | CONTROLLING      | OUTLET<br>VELOCITY | COMMENTS   |
| e Coellkins                   | <u>(+</u>  0. |      | 8,9         | 1.0     | 0.7                 | 0.5          | 0.7     | 0.5       | 0        |          |                 |           |             |            |            | ļ              | ۰       |          |               |              | ļ              | 8                | ,                  | <u>·</u>   |
| 21.5' s                       | pan >         | di   | 1.74        | ris     | e arc               | h wi         | th c    | pacre     | te fox   | tings    | (approx         | imately   | 1' 0        | f vert     | ical       | exposur        | e).     |          |               | İ            | ļ              |                  |                    |  |
|                               |               | 1    |             | X       |                     |              |         | -         | 11.7     | ,        | 0.4             | 4.7       | 0,7         |            |            | 7.0            |         | 7.0      | 3.6           | 3.6          | 0.3            | 4.7              | 10.5               | Barrel Velocity  |
|                               |               |      |             | X       |                     |              |         |           | 11.7     | 1160     | 0.7             | 8.2       | 0.7         | 0.8        | 4.7        | 8.2            | 3.9     | 8.2      | 3.6           | 5.4          | 0.5            | 8.2              | 14.7               | Barrel Velocity  |
|                               |               |      |             |         |                     |              |         |           |          |          |                 |           |             |            |            |                |         |          | •             |              |                |                  |                    |  |
|                               |               |      |             |         |                     |              |         |           |          |          |                 |           |             |            |            |                |         |          |               |              |                |                  |                    |  |
|                               |               |      |             | _       |                     |              |         |           |          |          |                 |           |             |            |            |                |         |          |               |              |                |                  |                    | ,  |
| or 02                         | Y AND         | RC   | COMM        | ENDA    | TIONS<br>Yb =       | - 10         | 5 fo    |           | <u> </u> | db = '   | 2 1 ft          | (n = 0.0) | ME)         | for +l     |            | luont ha       | l       |          |               |              |                | <b></b>          | ·                  |  |
| or 050                        |               |      |             |         |                     |              |         |           |          |          |                 | (n = 0.0) |             |            |            |                |         |          |               |              |                |                  |                    |  |
| • •                           |               |      |             |         |                     |              | - [-    |           |          |          |                 |           |             |            |            |                |         |          |               |              |                |                  |                    |  |
|                               |               |      |             |         |                     |              |         |           |          |          |                 |           |             |            |            |                |         |          |               |              |                |                  |                    |  |
| O ESC COLT                    |               |      |             |         |                     |              | ,       |           |          |          | if dirift       |           |             |            |            |                |         |          |               |              |                |                  |                    | ·  |

. .

| #= 10 - 01 q<br>(A). 0 - F2]         |                           | -              |       |                    | C              | ะบ     | LV           | EF                | ·<br>?T  | DE                   | SIC         | ЭŅ   | 8         | Н         | EET         | _      |              |  |      | · ·     |  | FEDERAL        | NTHENT OF TRA<br>HIGHWAY ADMO<br>CM VANCOUVER | CHOITARTEIN |
|--------------------------------------|---------------------------|----------------|-------|--------------------|----------------|--------|--------------|-------------------|----------|----------------------|-------------|------|-----------|-----------|-------------|--------|--------------|--|------|---------|--|----------------|---|-------------|
| Poop<br>USGS                         |                           |                | neite | 1401               | h Ho           | it Spi | rings<br>9   | , Oreg            | on"      | 2-B<br>1.75<br>7S    | es .        |      | . E C MAS | <b>-</b>  | ELEVA<br>E' | MIK(MU | <u> </u>     |  | /_   |         |  | _              | 2-B<br>. \$1A110#                             |             |
| a.5 —                                | 10                        | owni           | ng    | H                  |                | 1      |              | CT ye m           |          | 11/10<br>641<br>0.4' | <b>V8</b> 8 |      | #E BIDGA  |           | •           | Log    | <u>barri</u> | ers a  |      | let may |  | uence<br>event | culvert                                       | 44.5        |
| SIZE  INCHES  Ke Conflicient         | CONCARTE NOOVETINE        | PROJECTING     | Ti-   | STRUCTURALLIS      | VENTICAL TO    | MYTT2  | MOLIZE GKZ 5 | SIZE<br>D<br>FEET | a        | IKLET D              | CONTROL     | Ke   | н         | EADW<br>4 | OUILET      | COMIR  | Na PUTAT     | ніло   | ·IIW | HW.     | CONTROLLING                                      | OUTLET         | COMME   | ENTS        |
| 48" (MP<br>48" (MP                   |                           |                | X     |                    |                |        |              | 4                 | 10<br>35 | 0.4                  | 1.6         | 0.7  | 0.1       |           | 2.5         | 0.4    | 2.5          | <del>                                     </del> | 0.0  | 0       | <del>                                     </del> | 8.0<br>11.5    | Barrel Ve                                     |             |
|                                      |                           |                |       |                    |                |        |              |                   |          |                      |             |      |           |           |             |        |              |  |      |         |  |                |   |             |
| SUMMARY For Q2 = For Q50 = The Q2 ar | 10 cf<br>: 35 c<br>nd Q50 | s<br>fs<br>dis | chan  | Vb=<br>Vb=<br>gesa | : 8 f<br>: 11. | .5 fp  |              | 6<br>6<br>6       | qp⊢≖     | .65 ft.<br>1.2 ft.   | (n = 0.     | 024) | for the   | ne cu     | ivert ba    | arrel. |              |  |      |         |  |                |   |             |

| fn 18 - 18 d<br>(hec. B - 78 )         |                        |                     |             |                      |                         | ะบ             | LV              | EF                | :<br>?T | DE                         | SIC      | 3N  | S      | SH(         | EE7                | r <u>-</u> | •     |                 |       |                                       |             | PEDERAL            | TRIMENT OF TRANSPORTATION:<br>KIGHWAY ADWINISTRATION:<br>IEN YANCOUVER, WASHINGT |
|--|------------------------|---------------------|-------------|----------------------|-------------------------|----------------|-----------------|-------------------|---------|----------------------------|----------|-----|--------|-------------|--------------------|------------|-------|-----------------|-------|---------------------------------------|-------------|--------------------|--|
| Pine IISSS                             | Quad                   | k - "]              | erns        | ngd,                 |                         |                | 27              | 7                 |         | 3-A<br>4.0<br>6S<br>11/1/1 | 3E.      | •   | Equiac | _ <br> <br> | AND TO THE REMARKS | MIXIMU     |       | hSa             | 0.026 | · · · · · · · · · · · · · · · · · · · | 46'         |                    | 3-A<br>• • • • • • • • • • • • • • • • • • •                                     |
| 9-1+                                   | 6                      | 65 c1               | s           |                      | <u>.</u>                |                |                 |                   |         | 2,8'                       |          |     |        | _           |                    | ·          |       |                 |       |                                       |             |                    | ·  |
| <del></del>                            | <u> </u>               |                     |             | PIPE                 |                         |                | ,,              |                   |         |                            |          |     |        | EADW/       |                    |            | PUTAT |                 |       | -                                     |             |                    |  |
| SIZE<br>INCHES<br>Ka Castikinal-       | CONCRETE               | . <u>^</u> _        | NITERED 0.7 | STRUCTURAL<br>PLATE  | 1                       | MITERED        | C. END. SECTION | SIZE<br>D<br>rttr | o       | PLAK<br>PLAK               | HW       | Ke  | н      | đς          | dc+D               | TW         |       | LS <sub>0</sub> |       | HW.<br>D                              | CONTROLLING | OUTLET<br>VELOCITY | COMMENTS   |
| 7.5'. <b>ø</b>                         |                        | Х                   |             |                      |                         |                |                 | 7.5               | 250     | 0.75                       | 5.6      | 0.9 | 0.7    | 3.8         | 5.6                | 1.8        | 5.6   | 1.2             | 5.1   | 0.7                                   | 5.6         | 13.7               | Barrel Velocity  |
| 7.5' Ø                                 |                        | Х                   |             |                      |                         |                |                 | 7.5               | 665     | 1.5                        | 11.3     | 0.9 | 5.0    | 6.2         | 6.8                | 2.8        | 6.8   | 1.2             | 10.6  | 1.4                                   | 11.3        | 17.1               | Barrel Velocity  |
|  |                        |                     |             |                      |                         |                |                 |                   |         |                            |          |     |        |             |                    |            |       |                 |       |                                       |             |                    |  |
| ************************************** | 230 (<br>: 580<br>floo | cfs<br>cfs<br>od re | elief       | ∀b =<br>∀b =<br>pipx | = 13.<br>= 17.<br>= car | rri <u>e</u> s |                 | oxima             | tely 2  |                            | nd 85 ct |     |        |             |                    |            |       | /.              | .,    |                                       |             |                    | · · · · · · · · · · · · · · · · · · ·  |

| f m 40 - 534<br>tus 8 - 561 |                                      |                  |          |                                  | C        | U              | LV           | ΕF                | ?T          | DE         | 5810       | ξŅ               | 8        | H       | ΞΕΊ               | -                  |                |                   | -             |                  |                | FEDERAL            | ARTMENT OF TRANSPORTATI<br>, HISKWAY ADMINISTRATION<br>TEX YANCOWER, WASHING |
|-----------------------------|--------------------------------------|------------------|----------|----------------------------------|----------|----------------|--------------|-------------------|-------------|------------|------------|------------------|----------|---------|-------------------|--------------------|----------------|-------------------|---------------|------------------|----------------|--------------------|--|
|                             |                                      | raq              | JE 61 1  |                                  | <u>.</u> |                |              |                   | · · · · · · | 7-A        | Ľ4 .       |                  | <i>,</i> |         |                   |                    |                |                   |               |                  |                |                    | 7-A  |
| Haig                        | nt Cn                                |                  | 15145    | - RADE                           |          |                |              |                   |             | 4.0        | #41#10C EN | **               | ####E    | PEC 1   | 12                | MIKIMUI<br>MIKIMUI | ¥              |                   | $\overline{}$ |                  |                |                    |  |
| USGS                        | Quad                                 |                  | •        |                                  |          | regor          | <u>)"</u>    |                   |             |            | -          | - "<br>- <u></u> |          |         |                   |                    |                | _/                | <b>/</b> ,    | •                |                |                    |  |
|                             |                                      |                  |          |                                  |          |                | 34           |                   |             | <b>9</b> S | 7W         |                  | •        | .       | AHW .             |                    |                |                   |               |                  |                | /                  | \  |
|                             |                                      | 1466710          | Η.       | ,                                |          |                | 34           | Clien             |             | 1001(40    | 84*        | 14               | ME EI MA | -       |                   |                    | F              | ,<br>             |               | <u> </u>         | <u> </u>       | _ <u></u>          |  |
|                             | Bı                                   | ากกา<br>การเการ์ | na.      |                                  |          |                |              |                   |             | 11/1       | 0/88       |                  |          | -[      | <u>.</u>          |                    | <u>/</u>       | <del></del> -     |               | <u>~~</u>        | ~ <del>~</del> | _                  |  |
|                             |                                      | CPC              | CHED     | <del>e</del> T                   |          | -              |              |                   |             | 2.1        |            |                  |          |         | <u>are 476</u>    | 7                  |                |                   |               | 5 <sup>1</sup> / |                |                    | 476,4  |
| م-5 —                       | ·                                    | 90 cf            | -        |                                  |          | י —            | <b>*</b> 2 - |                   |             |            |            |                  |          | -       | WCÁYWKI"          | _Smal              | <u>l</u> gra   | vel a             | <u>nd sar</u> | <u>ndstone</u>   | e bed          | are lo             | xated  |
| Q***                        | 4                                    | 10 cf            | <u>s</u> |                                  | <u> </u> | '              | (#·H _       |                   |             | 3.1'       |            |                  |          |         | withir            | the J              | barre          | 1                 |               |                  |                |                    |  |
|                             |                                      | CUL              | 42       | DES                              | PIEAD    | WALLS          | 7            |                   | ,           | 1311 5 T   | CONTROL    | Υ                | Н        | EADW    | OUTLET            |                    | TATU           |                   | -215-         | •                | Τ              |                    |  |
| SIZE                        | CONCAETE<br>BROOVE-END<br>PROJECTINE | PROJECTING       | MITERED  | STRUCTURAL<br>PLATE<br>(witters) | VERTICAL | KITERED        | END. SECTION | SIZE<br>D<br>rect | q           | HW         | нж         | κ <sub>a</sub>   | н        | đς      | d <sub>c</sub> +0 | TW                 | h <sub>a</sub> | LS <sub>0</sub> . | hw            | HILL<br>HW.<br>D | CONTROLLING    | OUTLET<br>VELOCITY | COMMENTS   |
| Coofficient —               |                                      |                  |          |                                  | 0.5      | 0.7            | 0.5          | 0                 | · .         |            | ļ          |                  |          |         | ļ                 | •                  | ۰              |                   |               | <u> </u>         | 8              | °,5                |  |
| 3.2' X 8                    | .9'                                  |                  |          | Х                                |          |                | <u> </u>     | 8.9               | 190         | 0.4        | 4.5        | 0.7              | 0.2      | 1.7     | 5,3               | 2.1                | 5,3            | 0.1               | 5.4           | 0.6              | 5.4            | 3.1                | Barrel Velocit   |
| 3.2' X 8                    | .9¹                                  |                  |          | Х                                |          |                |              | 8.9               | 440         | 0.6        | 5.3        | 0.7              | 0.5      | 2.6     | 5.7               | 3.1                | 5.7            | 0.1               | 6.1           | 0.7              | 6.1            | 3.7                | Barrel Velocit   |
|                             |                                      |                  |          |                                  |          |                |              |                   |             |            |            |                  |          | •       |                   |                    |                |                   | <b></b>       |                  |                |                    |  |
| 1                           |                                      |                  |          |                                  |          |                | <u></u>      |                   |             |            |            |                  |          |         |                   |                    |                |                   |               |                  | _              |                    |  |
|                             |                                      |                  |          |                                  |          |                |              |                   | ĺ           |            |            |                  |          |         |                   |                    |                |                   |               |                  |                |                    |  |
|                             |                                      |                  |          |                                  |          |                |              |                   |             |            |            | <b> </b>         |          |         | -                 |                    |                |                   |               |                  |                |                    |  |
| UHMARY .                    |                                      |                  | EHDA     | TIONS                            | - 2 '    | 1 <i>6</i> -6  | l            | l                 | d           | 3.8 ft.    | /n - 0     | L<br>0251        | fon H    | 70. 611 | luort b           |                    |                |                   | ! <u></u>     | <u> </u>         |                | 1                  | · +  |
| or Q2 =<br>or Q50 =         |                                      |                  |          | Vb =                             | - J.     | i fps<br>7 foe |              | <u>მ</u>          |             | 8.0 ft.    |            |                  |          |         |                   |                    |                |                   |               |                  |                |                    |  |

NOTE: The above does not consider the influence of the Suislaw River located d/s from the culvert outlet. Based upon the field survey the river probably controls the hydraulic characteristics at the culvert site during high flows.

| (##:HI                   |  |                  |                       |                | C        | υ              | LV         | EF          | 27  | DE                 | SIC     | зŅ             | S        | Н    | ΞΕΊ                    | <b>-</b>      |          |                  |            |       |             | FEDERAL  | ATMENT OF TRANSPORTATION HISHWAY ACHINISTRATION ( |
|--------------------------|--|------------------|-----------------------|----------------|----------|----------------|------------|-------------|-----|--------------------|---------|----------------|----------|------|------------------------|---------------|----------|------------------|------------|-------|-------------|----------|---|
| Eam                      | es Cre   | at.              | 13151                 | 34.04<br>-     | · · ·    | •              |            | <del></del> |     | 7-B<br>5.2         |         |                | \$qwaf   |      | 11. EY-11              | NIK (MA)      |          |                  |            |       |             |          | 7-B<br>\$74164                                    |
|                          | S Quad   |                  | High                  |                | t, 0     | regor          | 7          | CTM4        |     | 198                | 6W      |                | b££ijki) | _    | AP)F# _                |               |          |                  | <b>/</b> . |       |             |          | \   |
|                          | E  | irown            | }+4=(A                | PY             | <u> </u> |                |            |             |     | 11/10              | 0/88    |                |          | -    | <u> </u><br>n.cx 48/   | 1.2 /         | Ç.,      |                  | 0,00       | 2'/'  | 56'         |          | nr. 484.1   |
| 0·10                     |  | 280 c:<br>340 c: | fs                    |                |          |                | **2 -      |             |     | 3,3'<br>5,0'       |         |                |          |      | of sar                 | <u>rdston</u> | e bed    | rock.            |            | n the | culve       | rt bärr  | rel consists                                      |
| SIZE                     | CALTE<br>SYC-END                                 | PROJECT MO       | VERT<br>AL<br>03KJ4IN | STRUCTURAL STA | FICAD    | TION           | SECTION    | SIZE        | ٥   | IKCET              | CONTROL |                |          | EADW | OUTLET                 | CONTRO        |          | - H I No         |            | unn   |             | r.E      | CONMENTS  |
| PMCHES<br>Ke Confficient | - 0.7  | 0.9              | 0.7                   | 0.1            | 0.5      | 0.7            | 9.5<br>0.5 | etti<br>0   |     | D                  | HW .    | K <sub>4</sub> | H        | 4ç   | d <sub>c</sub> †D<br>2 | e_            | <b>4</b> | L\$ <sub>0</sub> | HW         | HW.   | CONTROLLING | VELOCITY | ·   |
| 13.8' X                  | 1  | ri th            | appr                  | X              | tely     | 1.0            | of         | concr<br>8  | 280 | oting e            | 4.0     | 0.7            | 0.6      | 2.4  | 5.2                    | 3.3           | 5.2      | 0.1              | 5.7        | 0.7   | 5.7         | 4.0      | Barrel Velocity                                   |
| 13.8' X                  | *'<br>-  |                  | -<br>                 | х              |          |                |            | 8           | 640 | 1.0                | 8.0     | 0.7            | 2.5      | 4.5  | 6.2                    | 5.0           | 6.2      | 0.1              | 8.6        | 1.1   | 8.6         | 7.4      | Barrel Velocity                                   |
|                          | <del>                                     </del> | -                |                       |                |          |                |            |             |     |                    |         |                |          |      |                        |               |          |                  |            |       |             |          |   |
| For Q50                  | = 280  | cfs              |                       | Vb :           | = 4.(    | 0 fps<br>4 fps |            | @<br>@      |     | 5.6 ft.<br>8.0 ft. |         |                |          |      |                        |               |          |                  |            |       | <u> </u>    | <u> </u> | <u> </u>  |

D BSC KITCET BIENTSCO FOR BINOP FINES BSC KISC BIECOSION FOR ARCH COLVERTS

fiel other street

# APPENDIX F

STREAM BED MATERIAL GRADATION DATA

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0035

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE RECEIVED: 01-04-88

OWNER:

DATE SHIPPED: -

SAMPLE OF:

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

SAMPLED BY: BRYANT/HOWARD

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: MT. SCOTT CR CULVERT INTENDED USE:

NO. SACKS: DEPTH: SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 5 "    | 100.0   |
| 4 "    | 94.7    |
| 3 "    | 94.7    |
| 2"     | 90.4    |
| 1 1/2" | 84.8    |
| 1 "    | 69.0    |
| 3/4"   | 59.1    |
| 1/2"   | 43.8    |
| 3/8"   | 35.4    |
| #4     | 22.1    |
| #10    | 12.2    |
| #40    | 2.5     |
| #100   | 1.3     |
| #200   | 1.0     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0035)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0034

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87 DATE SHIPPED:

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893 DATE RECEIVED: 01-04-88

PHONE: 206-696-7767

SAMPLE OF:

SAMPLED BY: BRYANT/HOWARD SAMPLE NO.: NEWELL CREEK NO. SACKS: DEPTH: INTENDED USE:

SOURCE NO.: QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER: COUNTY: STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 3"     | 100.0   |
| 2 "    | 94.8    |
| 1 1/2" | 94.8    |
| 1"     | 91.2    |
| 3/4"   | 87.8    |
| 1/2"   | 80.0    |
| 3/8"   | 72.3    |
| #4     | 55.5    |
| #10    | 41.5    |
| #40    | 15.2    |
| #100   | 3.7     |
| #200   | 1.7     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0034)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0007

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER: SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE SAMPLED: 12-15-87

DATE SHIPPED: - -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: COOL CREEK CULVERT

INTENDED USE:

NO. SACKS: DEPTH: SOURCE NO.: - -

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 6"     | 100.0   |
| 5 "    | 89.7    |
| 4 "    | 85.7    |
| 3"     | 64.4    |
| 2"     | 51.5    |
| 1 1/2" | 47.7    |
| 1 "    | 41.9    |
| 3/4"   | 36.5    |
| 1/2"   | 27.5    |
| 3/8"   | 22.3    |
| #4     | 11.8    |
| #10    | 5.4     |
| #40    | 1.3     |
| #100   | 0.5     |
| #200   | 0.3     |
|        |         |

RAYMOND E. ROSENBAUM

CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0007)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0005

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87 ADDRESS: 610 E 5TH ST DATE SHIPPED: - -

> DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

PHONE: 206-696-7767 SAMPLE OF:

SAMPLE NO.: LOST CREEK CULVERT SAMPLED BY:

DEPTH: INTENDED USE:
- QUANTITY REPRESENTED: NO. SACKS: INTENDED USE:

SOURCE NO.:

SOURCE NAME:

LOCATION: OWNER:

STATE: OR TYPE OF DEPOSIT: COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE                                | PERCENT   |
|--------------------------------------|---|
| SIZE                                 | PASSING   |
| 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 | 100.0<br>93.6<br>83.8<br>76.9<br>60.6<br>54.0<br>46.5<br>42.9<br>35.6 |
| #10                                  | 27.0  |
| #40                                  | 4.8   |
| #100                                 | 0.8   |
| #200                                 | 0.3   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0005)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0008

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE SAMPLED: 12-15-87

DATE SHIPPED: -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

DEPTH:

SAMPLE NO.: POLALLIE CREEK

INTENDED USE:

SOURCE NO.: - -

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

\* \* \* \* \*

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 7 "    | 100.0   |
| 6 "    | 77.3    |
| 4 "    | 64.1    |
| 3 "    | 54.6    |
| 2 "    | 40.8    |
| 1 1/2" | 31.0    |
| 1"     | 25.3    |
| 3/4"   | 22.1    |
| 1/2"   | 18.1    |
| 3/8"   | 15.9    |
| #4     | 12.4    |
| #10    | 9.3     |
| #40    | 4.3     |
| #100   | 1.2     |
| #200   | 0.4     |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0008)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0020

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87

ADDRESS: 610 E 5TH ST DATE SHIPPED: - -DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

SAMPLE OF:

PHONE: 206-696-7767 SAMPLE NO.: MOFFET CREEK SAMPLED BY:

DEPTH: INTENDED USE:
- QUANTITY REPRESENTED: NO. SACKS:

SOURCE NO.: - -

SOURCE NAME:

LOCATION: OWNER: STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 5 "    | 100.0   |
| 4 "    | 90.6    |
| 3 "    | 79.0    |
| 2 "    | 51.5    |
| 1 1/2" | 39.9    |
| 1"     | 27.5    |
| 3/4"   | 22.7    |
| 1/2"   | 17.1    |
| 3/8"   | 14.5    |
| #4     | 9.4     |
| #10    | 5.4     |
| #40    | 1.7     |
| #100   | 0.9     |
| #200   | 0.6     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0020)

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0019

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87
ADDRESS: 610 E 5TH ST DATE SHIPPED: - -

VANCOUVER WA 98661-3893 DATE RECEIVED: 01-04-88

PHONE: 206-696-7767 SAMPLE OF:

SAMPLED BY: SAMPLE NO.: LITTLE LOOKINGGLASS

NO. SACKS: DEPTH: INTENDED USE: SOURCE NO.: - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: OWNER:

COUNTY: STATE: OR TYPE OF DEPOSIT:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE                                       | PERCENT   |
|---|---|
| SIZE  | PASSING   |
| 5" 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 | 100.0<br>91.6<br>80.9<br>69.4<br>63.8<br>49.0<br>41.0<br>31.0<br>26.3<br>17.2<br>9.4<br>1.8 |
| #100  | 0.9   |
| #200  | 0.6   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0019)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0033

AGENCY: WDFD PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

DATE SAMPLED: 12-15-87 SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

DATE SHIPPED: DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

PHONE: 206-696-7767 SAMPLE OF:

SAMPLE NO .: TAMARACK GULCH SAMPLED BY: BRYANT/HOWARD

NO. SACKS: DEPTH: INTENDED USE:

SOURCE NAME:

SOURCE NO.: QUANTITY REPRESENTED:

LOCATION: OWNER: COUNTY: STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 4 "    | 100.0   |
| 3 "    | 93.2    |
| 2 "    | 86.5    |
| 1 1/2" | 77.6    |
| 1"     | 65.8    |
| 3/4"   | 60.5    |
| 1/2"   | 55.5    |
| 3/8"   | 53.9    |
| #4     | 50.3    |
| #10    | 28.8    |
| #40    | 13.9    |
| #100   | 9.4     |
| #200   | 5.0     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0033)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0004

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

DEPTH:

SAMPLE NO.: S. F. CHESNIMUS CREEK INTENDED USE:

SOURCE NO.: **OUANTITY REPRESENTED:** 

SOURCE NAME:

LOCATION:

OWNER:

STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE   | PERCENT<br>PASSING   |
|---|--|
| 5" 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 #40 #100 #200 | 100.0<br>86.8<br>86.8<br>82.9<br>74.4<br>62.9<br>56.2<br>45.9<br>39.7<br>30.0<br>18.9<br>6.3 |
| # 200   | 1.6  |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0002

AGENCY: WDFD PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: DEVILS RUN CREEK

INTENDED USE:

NO. SACKS: DEPTH: INTENDED USE: SOURCE NO.: - - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE      | PERCENT |
|------------|---------|
| SIZE       | PASSING |
|            |         |
| <b>4</b> " | 100.0   |
| 3 "        | 95.6    |
| 2 "        | 72.2    |
| 1 1/2"     | 58.8    |
| 1"         | 44.9    |
| 3/4"       | 37.6    |
| 1/2"       | 29.8    |
| 3/8"       | 25.9    |
| #4         | 19.3    |
| #10        | 11.5    |
| #40        | 1.8     |
| #100       | 0.8     |
| #200       | 0.4     |
|            |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0002)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0012

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

SAMPLE NO.: BILLY CREEK DEPTH:

INTENDED USE:

SOURCE NO.: - -

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE                                     | PERCENT<br>PASSING   |
|---|--|
| 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 #40 #100 | 100.0<br>90.4<br>74.6<br>66.0<br>53.8<br>46.8<br>37.8<br>33.3<br>24.8<br>15.2<br>2.5 |
| #200  | 0.7  |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0006

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: CAMP CREEK

NO. SACKS: DEPTH: INTENDED USE: SOURCE NO.: - -QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: OWNER:

COUNTY: STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE | PERCENT<br>PASSING |
|---------------|--------------------|
| 5 "           | 100.0              |
| 4"            | 89.6               |
| 3"            | 83.4               |
| 2 "           | 76.9               |
| 1 1/2"        | 72.1               |
| 1 "           | 60.1               |
| 3/4"          | 51.4               |
| 1/2"          | 40.2               |
| 3/8"          | 34.8               |
| #4            | 25.8               |
| #10           | 18.1               |
| #40           | 1.6                |
| #100          | 0.1                |
| #200          | 0.1                |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0006)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0017

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: DOE CREEK

NO. SACKS: DEPTH:

SOURCE NO.: - -

INTENDED USE:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER: STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| PERCENT |
|---------|
| PASSING |
| 100.0   |
| 94.4    |
| 83.4    |
| 70.5    |
| 62.5    |
| 47.8    |
| 40.7    |
| 33.9    |
| 31.1    |
| 25.6    |
| 17.0    |
| 2.2     |
| 1.0     |
| 0.6     |
|         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0017)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0014

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD PROJECT NUMBER:

ACCT NO.: 191-17-41-51-0000-002H DATE SAMPLED: 12-15-87

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: GUMBOOT CREEK

DATE RECEIVED: 01-04-88

DATE SHIPPED:

SAMPLE OF:

SAMPLED BY: NO. SACKS:

INTENDED USE: DEPTH:

SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: SITE D7

OWNER:

COUNTY: REMARKS:

STATE: OR TYPE OF DEPOSIT:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 6"     | 100.0   |
| 5"     | 79.1    |
| 4 "    | 72.1    |
| 3 "    | 65.9    |
| 2 "    | 41.5    |
| 1 1/2" | 34.1    |
| 1"     | 25.5    |
| 3/4"   | 21.6    |
| 1/2"   | 15.6    |
| 3/8"   | 12.9    |
| #4     | 7.9     |
| #10    | 3.1     |
| #40    | 0.3     |
| #100   | 0.1     |
| #200   | 0.1     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0014)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0037

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
PROJECT NUMBER:
DATE SAMPLED:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLED BY: BRYANT/HOWARD

NO. SACKS: DEPTH:

SAMPLE NO.: ELK CREEK

INTENDED USE:

SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

COUNTY:

OWNER:

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE SHIPPED: - -

DATE RECEIVED: 01-04-88

SAMPLE OF:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 5 "    | 100.0   |
| 4 "    | 83.3    |
| 3 "    | 76.0    |
| 2 "    | 48.1    |
| 1 1/2" | 37.0    |
| 1 "    | 28.9    |
| 3/4"   | 20.7    |
| 1/2"   | 12.4    |
| 3/8"   | 9.3     |
| #4     | 5.1     |
| #10    | 2.5     |
| #40    | 1.0     |
| #100   | 0.6     |
| #200   | 0.3     |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0037)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0003

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

DEPTH:

SAMPLE NO.: CHESNIMUS CREEK

INTENDED USE:

SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
| 4.0    | 100 0   |
| 4 "    | 100.0   |
| 3 "    | 84.5    |
| 2 "    | 68.8    |
| 1 1/2" | 57.1    |
| 1"     | 46.2    |
| 3/4"   | 41.3    |
| 1/2"   | 34.2    |
| 3/8"   | 31.0    |
| #4     | 23.6    |
| #10    | 11.1    |
| #40    | 2.6     |
| #100   | 1.4     |
| #200   | 0.9     |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0003)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0018

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: CROW CREEK

SAMPLED BY: NO. SACKS:

DEPTH: INTERCED: INTENDED USE:

SOURCE NO.: SOURCE NAME:

LOCATION: 0+11 11.5RT

COUNTY: REMARKS:

OWNER:

STATE: OR TYPE OF DEPOSIT:

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE SHIPPED: - . DATE RECEIVED: 01-04-88

SAMPLE OF:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 5"     | 100.0   |
| 4 "    | 87.8    |
| 3 "    | 87.8    |
| 2 "    | 75.1    |
| 1 1/2" | 71.2    |
| 1 "    | 67.7    |
| 3/4"   | 62.4    |
| 1/2"   | 51.9    |
| 3/8"   | 43.5    |
| #4     | 24.5    |
| #10    | 11.5    |
| #40    | 3.1     |
| #100   | 1.4     |
| #200   | 0.8     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0018)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0009

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE SHIPPED: - -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

SAMPLE NO.: MEACHAM CREEK NO. 1

DEPTH: INTENDED USE: - - QUANTITY REPRESENTED: INTENDED USE:

SOURCE NO.: SOURCE NAME:

LOCATION: SITE 1

OWNER:

STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE | PERCENT<br>PASSING |
|---------------|--------------------|
| 4 "<br>3 "    | 100.0<br>97.2      |
| 2 "           | 86.4               |
| 1 1/2"        | 79.8               |
| 1"            | 60.3               |
| 3/4"          | 48.2               |
| 1/2"          | 36.9               |
| 3/8"          | 32.0               |
| #4            | 23.3               |
| #10           | 15.0               |
| #40           | 4.7                |
| #100          | 2.5                |
| #200          | 1.4                |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0009)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0010

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE SAMPLED: 12-15-87

DATE SHIPPED: -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: NO. SACKS:

SAMPLE NO.: MEACHAM CREEK NO. 6

INTENDED USE:

SOURCE NO.:

DEPTH: INTERESENTED:

SOURCE NAME:

LOCATION: SITE 5

OWNER:

STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 4 "    | 100.0   |
| 3 "    | 95.4    |
| 2 "    | 84.9    |
| 1 1/2" | 76.4    |
| 1 "    | 54.4    |
| 3/4"   | 46.1    |
| 1/2"   | 35.9    |
| 3/8"   | 31.4    |
| #4     | 23.9    |
| #10    | 15.3    |
| #40    | 3.9     |
| #100   | 1.6     |
| #200   | 0.9     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0036

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: MEACHAM CREEK NO. 7

DATE SHIPPED: -

DATE SAMPLED: 12-15-87

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: BRYANT/HOWARD NO. SACKS: DEPTH:

INTENDED USE:

SOURCE NO.:

- - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: SITE 6

OWNER:

COUNTY: REMARKS:

STATE: OR TYPE OF DEPOSIT:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE        | PERCENT<br>PASSING |
|----------------------|--------------------|
| 5 "<br>4 "           | 100.0<br>92.4      |
| 3"<br>2"             | 88.7<br>70.1       |
| 1 1/2"<br>1"<br>3/4" | 53.5<br>29.2       |
| 1/2"<br>3/8"         | 15.3<br>7.2<br>5.2 |
| #4<br>#10            | 3.3                |
| #40<br>#100          | 1.2                |
| #200                 | 0.4                |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0011

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLED BY:

SAMPLE NO.: SHEEP CREEK

NO. SACKS:

NO. SACKS: DEPTH: INTENDED USE: SOURCE NO.: - QUANTITY REPRESENTED: INTENDED USE:

SOURCE NAME:

LOCATION: SITE 8

COUNTY:

OWNER:

SAMPLE OF:

AGENCY: WDFD

DATE SAMPLED: 12-15-87 DATE SHIPPED: - -

DATE RECEIVED: 01-04-88

STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 7 "    | 100.0   |
| 6 "    | 72.5    |
| 4 "    | 72.5    |
| 3 "    | 57.2    |
| 2"     | 33.6    |
| 1 1/2" | 23.8    |
| 1 "    | 16.9    |
| 3/4"   | 14.6    |
| 1/2"   | 11.2    |
| 3/8"   | 9.8     |
| #4     | 6.6     |
| #10    | 3.3     |
| #40    | 0.9     |
| #100   | 0.5     |
| #200   | 0.3     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0011)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0022

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO .: CANYON CREEK NO.1 INTENDED USE:

NO. SACKS: SOURCE NO.:

DEPTH: INTENDED USE:
- - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: WICKIUP CAMPGROUND

OWNER:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
| 4 "    | 100.0   |
| 3 "    | 89.7    |
| 2"     | 72.7    |
| 1 1/2" | 67.9    |
| 1 "    | 56.5    |
| 3/4"   | 49.5    |
| 1/2"   | 40.4    |
| 3/8"   | 36.0    |
| #4     | 26.2    |
| #10    | 16.2    |
| #40    | 3.3     |
| #100   | 0.9     |
| #200   | 0.5     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0022)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0024

PROJECT NAME: FISH PASSAGE STUDY AGENCY: ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE RECEIVED: 01-04-88

AGENCY: WDFD

DATE SAMPLED: 12-15-87

SAMPLE OF: SAMPLE NO.: MIDDLE FK. CANYON CR

DATE SHIPPED:

SAMPLED BY: BRYANT/HOWARD SAMPLED BY: BRIANT, ...
NO. SACKS: DEPTH: INTENDED ...
QUANTITY REPRESENTED:

INTENDED USE:

SOURCE NAME:

LOCATION:

COUNTY:

OWNER: STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE | PERCENT<br>PASSING |
|---------------|--------------------|
| 514E          | PASSING            |
| 5 "           | 100.0              |
| 4 "           | 96.1               |
| 3"            | 96.1               |
| 2 "           | 93.6               |
| 1 1/2"        | 85.8               |
| 1"            | 73.2               |
| 3/4"          | 63.7               |
| 1/2"          | 52.0               |
| 3/8"          | 45.2               |
| #4            | 31.7               |
| #10           | 18.6               |
| #40           | 3.4                |
| #100          | 1.1                |
| #200          | 0.6                |

RAYMOND E. ROSENBAUM

CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0024)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0023

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: CANYON CREEK NO. 3 INTENDED USE:

NO. SACKS: DEPTH: SOURCE NO.: QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: SITE 3

OWNER:

STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE                            | PERCENT<br>PASSING  |
|--|---|
| 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 | 100.0<br>87.9<br>68.0<br>62.3<br>50.5<br>44.9<br>37.4<br>33.0<br>23.7<br>17.1 |
| #100<br>#200                             | 1.0   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0023)

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0016

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: -

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: RUBY CREEK

NO. SACKS: DEPTH:

SOURCE NO.: - -

INTENDED USE:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: COUNTY:

OWNER: STATE: OR TYPE OF DEPOSIT:

REMARKS:

SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
| 4 "    | 100.0   |
|        |         |
| 3 "    | 93.7    |
| 2 "    | 85.8    |
| 1 1/2" | 78.0    |
| l "    | 64.7    |
| 3/4"   | 57.4    |
| 1/2"   | 48.2    |
| 3/8"   | 42.5    |
| #4     | 31.2    |
| #10    | 20.2    |
| #40    | 5.0     |
| #100   | 1.6     |
| #200   | 0.8     |

RAYMOND E. ROSENBAUM

CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0016)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0029

AGENCY: WDFD

DATE SAMPLED: 12-15-87

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLED BY: BRYANT/HOWARD

DATE RECEIVED: 01-04-88 SAMPLE OF:

SAMPLE NO.: BIG CREEK

DATE SHIPPED:

PROJECT NUMBER:

NO. SACKS: DEPTH: INTENDED USE:

SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

COUNTY:

OWNER: STATE: OR TYPE OF DEPOSIT:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE   | PERCENT<br>PASSING  |
|---|---|
| 7" 6" 5" 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 #40 #100 #200 | 100.0<br>86.5<br>86.5<br>76.4<br>56.9<br>48.5<br>42.5<br>33.9<br>28.9<br>24.0<br>21.4<br>15.5<br>10.9<br>3.6<br>0.9 |
| πεσσ  | 0.4   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0015

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: - ·

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: INDIAN CREEK

NO. SACKS:

DEPTH:

INTENDED USE:

SOURCE NO.:

DEPTH: INTENDED USE:
- - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER:

COUNTY:

STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
| 4"     | 100.0   |
| -      |         |
| 3 "    | 91.7    |
| 2 "    | 61.0    |
| 1 1/2" | 44.3    |
| 1 "    | 33.5    |
| 3/4"   | 28.4    |
| 1/2"   | 21.0    |
| 3/8"   | 17.9    |
| #4     | 11.8    |
| #10    | 7.4     |
| #40    | 2.7     |
| #100   | 1.1     |
| #200   | 0.6     |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

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FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0015)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0028

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87 ADDRESS: 610 E 5TH ST DATE SHIPPED: -

DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

SAMPLE OF:

SAMPLE NO .: GRANITE NO. 1

PHONE: 200-055

SAMPLED BY: BRYANT/HOWARD

NO. SACKS: DEPTH: INTENDED USE:
QUANTITY REPRESENTED:

LOCATION: SITE 1

OWNER: STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE   | PERCENT<br>PASSING  |
|---|---|
| 7" 6" 5" 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 #40 #100 #200 | 100.0<br>89.7<br>89.7<br>79.5<br>65.9<br>56.0<br>41.4<br>35.0<br>27.0<br>22.8<br>15.7<br>8.5<br>1.6<br>0.7<br>0.4 |
|   |   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0028)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0027

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87 DATE SHIPPED: - -ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893 DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLE NO.: GRANITE NO. 2

PHONE: 200-050.

SAMPLED BY: BRYANT/HOWARD

NO. SACKS: DEPTH: INTENDED USE:
QUANTITY REPRESENTED:

LOCATION: SITE 2 OWNER:

STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

# SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE   | PERCENT<br>PASSING   |
|---|--|
| 7" 6" 5" 4" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 #40 #100 #200 | 100.0<br>90.5<br>84.2<br>60.3<br>50.2<br>41.6<br>34.7<br>28.5<br>24.5<br>20.5<br>18.0<br>13.9<br>9.5<br>2.5<br>1.1 |
|   | *  |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0026

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

PROJECT NUMBER: ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87 ADDRESS: 610 E 5TH ST DATE SHIPPED: - -

DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

PHONE: 206-696-7767 SAMPLE OF:

SAMPLE NO.: GRANITE NO. 3 SAMPLED BY: BRYANT/HOWARD

SAMPLED BY: BRITALING NO. SACKS: DEPTH: INTERPED: QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: SITE 3 OWNER:

STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 5 "    | 100.0   |
| 4 "    | 79.7    |
| 3 "    | 68.1    |
| 2 "    | 54.4    |
| 1 1/2" | 48.3    |
| 1 "    | 40.6    |
| 3/4"   | 36.2    |
| 1/2"   | 30.5    |
| 3/8"   | 28.2    |
| #4     | 22.9    |
| #10    | 15.0    |
| #40    | 4.0     |
| #100   | 1.6     |
| #200   | 0.9     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0026)

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0021

PROJECT NAME: FISH PASSAGE STUDY AGENCY: WDFD

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87
ADDRESS: 610 E 5TH ST DATE SHIPPED: - -

VANCOUVER WA 98661-3893 DATE RECEIVED: 01-04-88

PHONE: 206-696-7767 SAMPLE OF:

SAMPLED BY:

SAMPLE NO.: SUNFLOWER CREEK

NO. SACKS: DEPTH: INTENDED USE: SOURCE NO.: - QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION: OWNER:

COUNTY: STATE: OR TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE | PERCENT<br>PASSING |
|---------------|--------------------|
| 8 "<br>7 "    | 100.0<br>67.9      |
| 3 °           | 58.3               |
| 2 "           | 42.6               |
| 1 1/2"        | 32.5               |
| 1"            | 26.0               |
| 3/4"          | 23.3               |
| 1/2"          | 19.5               |
| 3/8"          | 17.5               |
| #4            | 13.2               |
| #10           | 8.6                |
| #40           | 1.7                |
| #100          | 0.4                |
| #200          | 0.2                |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0021)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0025

AGENCY: WDFD PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER:

DATE SAMPLED: 12-15-87 SUBMITTED BY: MARK BROWNING DATE SHIPPED: -

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: MARKS CREEK

SAMPLE OF:

SAMPLED BY: BRYANT/HOWARD SAMPLE NO..

DEDTH: INTENDED USE: QUANTITY REPRESENTED: SOURCE NO.:

SOURCE NAME:

LOCATION:

OWNER:

DATE RECEIVED: 01-04-88

STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 6 "    | 100.0   |
| 5 "    | 93.6    |
| 4 "    | 93.6    |
| 3 "    | 88.3    |
| 2 "    | 82.5    |
| 1 1/2" | 78.7    |
| 1 "    | 67.3    |
| 3/4"   | 59.4    |
| 1/2"   | 45.2    |
| 3/8"   | 37.5    |
| #4     | 23.0    |
| #10    | 13.9    |
| #40    | 5.0     |
| #100   | 1.3     |
| #200   | 0.6     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0025)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0001

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: DATE RECEIVED: 01-04-88

SAMPLE OF: SAMPLE NO.: BROWNS CREEK

SAMPLED BY: NO. SACKS:

DEPTH: INTENDED USE:
- - QUANTITY REPRESENTED:

SOURCE NO.: SOURCE NAME:

OWNER:

LOCATION: COUNTY:

STATE: OR

TYPE OF DEPOSIT:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 3 "    | 100.0   |
| 2 "    | 96.1    |
| 1 1/2" | 92.4    |
| 1 "    | 76.6    |
| 3/4"   | 66.4    |
| 1/2"   | 51.1    |
| 3/8"   | 42.5    |
| #4     | 24.6    |
| #10    | 12.7    |
| #40    | 3.5     |
| #100   | 0.4     |
| #200   | 0.2     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0001)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0032

AGENCY: WDFD PROJECT NAME: FISH PASSAGE STUDY PROJECT NUMBER:

ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE OF: SAMPLE NO.: LOWE CREEK

SAMPLED BY: BRYANT/HOWARD NO. SACKS: DEPTH: INTENDED USE:

SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

STATE: OR TYPE OF DEPOSIT:

OWNER:

DATE SAMPLED: 12-15-87

DATE SHIPPED: - -DATE RECEIVED: 01-04-88

COUNTY: REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
|        |         |
| 6 "    | 100.0   |
| 5 "    | 89.5    |
| 4 "    | 76.3    |
| 3 "    | 74.0    |
| 2 "    | 60.4    |
| 1 1/2" | 53.0    |
| 1 "    | 37.2    |
| 3/4"   | 29.0    |
| 1/2"   | 20.7    |
| 3/8"   | 17.1    |
| #4     | 12.1    |
| #10    | 8.5     |
| #40    | 2.7     |
| #100   | 1.1     |
| #200   | 0.7     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0032)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0030

PROJECT NAME: FISH PASSAGE STUDY

ACCT NO.: 191-17-41-51-0000-002H PROJECT NUMBER: SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

VANCOUVER WA 98661-3893

PHONE: 206-696-7767

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH: INTENDED USE:
SOURCE NO.: - QUANTITY REPRESENTED:

SAMPLE NO.: POOP CREEK

SOURCE NAME:

LOCATION:

OWNER: STATE: OR TYPE OF DEPOSIT:

COUNTY:

REMARKS:

AGENCY: WDFD

DATE SAMPLED: 12-15-87

DATE SHIPPED: - -

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE<br>SIZE                               | PERCENT<br>PASSING  |
|---|---|
| 8" 6" 3" 2" 1 1/2" 1" 3/4" 1/2" 3/8" #4 #10 | 91.7<br>82.3<br>82.3<br>58.0<br>45.1<br>32.5<br>25.1<br>17.2<br>13.1<br>5.5 |
| #40   | 0.7   |
| #100  | 0.3   |
| #200  | 0.1   |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0030)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0031

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H AGENCY: WDFD

PROJECT NUMBER:

SUBMITTED BY: MARK BROWNING DATE SAMPLED: 12-15-87

ADDRESS: 610 E 5TH ST

DATE RECEIVED: 01-04-88 VANCOUVER WA 98661-3893

PHONE: 206-696-7767

SAMPLE NO.: PINE CREEK

SAMPLED BY: BRYANT/HOWARD SAMPLE NO..
INTENDED USE: 

LOCATION: OWNER: STATE: OR TYPE OF DEPOSIT: COUNTY:

REMARKS:

#### SIEVE ANALYSIS AS RECEIVED

| SIEVE  | PERCENT |
|--------|---------|
| SIZE   | PASSING |
| 7"     | 100.0   |
| 6 "    | 80.4    |
| _      |         |
| 4 "    | 68.9    |
| 3 "    | 62.5    |
| 2 "    | 59.0    |
| 1 1/2" | 48.8    |
| 1 "    | 33.7    |
| 3/4"   | 26.2    |
| 1/2"   | 18.9    |
| 3/8"   | 16.0    |
| #4     | 9.7     |
| #10    | 5.2     |
| #40    | 1.4     |
| #100   | 0.6     |
| #200   | 0.3     |
|        |         |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0031)

REPORT OF TESTING Aug 21, 1990 LABORATORY CONTROL NUMBER AG88-01-0038

PROJECT NAME: FISH PASSAGE STUDY ACCT NO.: 191-17-41-51-0000-002H

SUBMITTED BY: MARK BROWNING

ADDRESS: 610 E 5TH ST

PHONE: 206-696-7767

VANCOUVER WA 98661-3893

AGENCY: WDFD

PROJECT NUMBER:

DATE SAMPLED: 12-15-87

DATE SHIPPED:

DATE RECEIVED: 01-04-88

SAMPLE OF:

SAMPLED BY: BRYANT/HOWARD

SAMPLE NO.: HAIGHT CREEK

INTENDED USE:

NO. SACKS: DEPTH: SOURCE NO.:

QUANTITY REPRESENTED:

SOURCE NAME:

LOCATION:

OWNER: STATE: OR TYPE OF DEPOSIT:

COUNTY: REMARKS:

SIEVE ANALYSIS AS RECEIVED

| SIEVE       | PERCENT    |
|-------------|------------|
| SIZE        | PASSING    |
| 3"          | 100.0      |
| 2"          | 94.9       |
| 1 1/2"      | 84.0       |
| 1"          | 66.9       |
| 3/4"        | 58.6       |
| 1/2"        | 47.4       |
| 3/8"        | 41.6       |
| #4          | 31.5       |
| #10         | 26.0       |
| #40<br>#100 | 9.2        |
| #200        | 1.6<br>0.8 |

RAYMOND E. ROSENBAUM CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0038)

# APPENDIX G

OUTLET SCOUR ANALYSES

| LIST 0 | )F 3 | SYMBOLS | CNA | DIMENSIONS |
|--------|------|---------|-----|------------|
|--------|------|---------|-----|------------|

| Q2  | Two year flood, in cubic feet per second (cfs)  |
|-----|---|
| Q50 | Fifty year flood, in cubic feet per second (cfs)  |
| D50 | Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft) $\frac{1}{2}$ |
| WT  | Culvert tailwater, in feet (ft)   |
| ٧0  | Culvert outlet velocity, in feet per second (fps)   |
| WO  | Width of culvert outlet, in feet (ft)   |
| A   | Flow area at the culvert outlet, in square feet ( $\mathrm{ft}^2$ ), or culvert drainage area in square miles         |
| YE  | Equivalent depth at the culvert outlet, in feet (ft)  |
| FR  | Froude number   |
| HS  | Scour depth at culvert outlet, in feet (ft)   |

| FL00D | Q   | VO   | D50   | TW  | WO   | Α  | YE  |  | нs  |  |  |
|-------|-----|--|---|---|--|--|---|--|---|--|--|
|       |     |  |   |   |  |  | FT  | FR   | FT  | TW/YE  | HS/D50   |
| , ALQ |     |  | <del></del>   |   |  |  |   |  | · · · · · · · · · · · · · · · · · · ·   |  |  |
| 2     | 170 | 11.00  | 0.06  | 1.70  | 10.00  | 15.45  | 2.78  | 1.16   | 4.29  | 0.61   | 71.50  |
| 50    | 260 | 15,00  | 0.06  | 3.00  | 10.00  | 17.33  | 2.94  | 1.54   | 8.02  | 1.02   | 133.68   |
| 2     | 95  | 4.00   | 0.01  | 1.60  | 14.00  | 23.75  | 3.45  | 0.38   | -3.11   | 0.46   | -474.53  |
| 50    | 275 | 6.00   | 0.01  | 2.80  | 14.00  | 45.83  | 4.79  | 0.48   | -2.78   | 0.58   | -423.10  |
|       | 145 | 4.60   | 0.17  | 2.50  | 14.00  | 31.52  | 3.97  | 0.41   | -3.25   | 0.63   | -19.12   |
|       | 365 | 6.30   | 0.17  | 5.60  | 14.00  | 57.94  | 5.38  | 0.48   | -3.20   | 1.04   | -18.82   |
|       | 255 | 5.80   | 0.06  | 2.50  | 18.20  | 43.97  | 4.69  | 0.47   | -2.88   | 0.53   | -48.05   |
|       | 650 | 8.20   | 0.06  | 4.70  | 18.20  | 79.27  | 6.30  | 0.58   | -1.83   | 0.75   | -30.45   |
|       | 265 | 21.50  | 0.25  | 3.30  | 12.70  | 12.33  | 2.48  | 2.40   | 13.47   | 1.33   | 53.87  |
|       | 690 | 29.50  | 0.25  | 4.70  | 12.70  | 23.39  | 3.42  | 2.81   | 22.90   | 1.37   | 91.58  |
|       |     |  | 0.17  | 3.00  | 5.67   | 7.62   | 1.95  | 2.07   | 8.54  | 1.54   | 50.23  |
|       |     |  | 0.17  | 4.90  | 5.67   | 18.29  | 3.02  | 2.08   | 13.31   | 1.62   | 78.31  |
|       |     |  | 0.08  | 2.40  | 17.50  | 32.50  | 4.03  | 0.53   | -1.79   | 0.60   | -22.39   |
|       |     |  | 0.08  | 4.60  | 17.50  | 70.00  | 5.92  | 0.58   | -1.65   | 0.78   | -20.61   |
|       |     |  |   | 0.80  | 6.00   | 2.00   | 1.00  | 0.97   | 0.94  | 0.80   | 46.94  |
|       |     |  | 0.02  | 1.40  | 6.00   | 5.73   | 1.69  | 1.30   | 3.34  | 0.83   | 167.03   |
|       |     |  |   | 0.60  | 6.70   | 2.88   | 1.20  | 1.29   | 2.32  | 0.50   | 37.09  |
|       |     |  |   | 1.30  | 6.70   | 8.56   | 2.07  | 1.53   | 5.58  | 0.63   | 89.24  |
|       |     |  |   | 0.90  | 10.20  | 7.57   | 1.95  | 0.47   | -1.22   | 0.46   | -9.79  |
|       |     |  |   |   | 10.20  | 22,63  | 3.36  | 0.55   | -1.27   | 0.56   | -10.19   |
|       |     |  |   |   | 6.30   | 10.00  | 2.24  | 0.53   | -0.97   | 0.85   | -12.10   |
|       |     |  |   |   |  | 17.61  | 2.97  | 0.73   | 0.53  | 1.01   | 6.68   |
|       |     |  |   |   | 7.50   | 18.21  | 3.02  | 0.85   | 1.73  | 0.53   | 28.82  |
|       |     |  |   |   |  | 44.86  | 4.74  | 1.12   | 6.64  | 0.70   | 110.68   |
|       |     |  |   |   |  |  | 1.79  | 0.51   | -0.87   | 0.61   | -10.85   |
|       |     |  |   |   |  |  |   | 0.61   | -0.55   | 0.88   | -6.82  |
|       | 50  | 2 170 50 260 2 95 50 275 2 145 50 365 2 255 50 650 2 265 50 690 2 125 50 375 2 195 50 560 2 11 50 55 2 23 50 107 2 28 50 129 2 45 50 125 2 153 50 619 2 25 | 2       170       11.00         50       260       15.00         2       95       4.00         50       275       6.00         2       145       4.60         50       365       6.30         2       255       5.80         50       650       8.20         2       265       21.50         50       690       29.50         2       125       16.40         50       375       20.50         2       195       6.00         50       560       8.00         2       11       5.50         50       55       9.60         2       23       8.00         50       107       12.50         2       28       3.70         50       129       5.70         2       45       4.50         50       125       7.10         2       153       8.40         50       619       13.80         2       25       3.90 | 2       170       11.00       0.06         50       260       15.00       0.06         2       95       4.00       0.01         50       275       6.00       0.01         2       145       4.60       0.17         50       365       6.30       0.17         2       255       5.80       0.06         50       650       8.20       0.06         2       265       21.50       0.25         50       690       29.50       0.25         2       125       16.40       0.17         50       375       20.50       0.17         2       195       6.00       0.08         50       560       8.00       0.08         50       560       8.00       0.08         2       11       5.50       0.02         2       23       8.00       0.06         2       23       8.00       0.06         2       28       3.70       0.13         50       129       5.70       0.13         2       45       4.50       0.08         50 | 2       170       11.00       0.06       1.70         50       260       15.00       0.06       3.00         2       95       4.00       0.01       1.60         50       275       6.00       0.01       2.80         2       145       4.60       0.17       2.50         50       365       6.30       0.17       5.60         2       255       5.80       0.06       2.50         50       650       8.20       0.06       4.70         2       265       21.50       0.25       3.30         50       690       29.50       0.25       4.70         2       125       16.40       0.17       3.00         50       375       20.50       0.17       4.90         2       195       6.00       0.08       2.40         50       560       8.00       0.08       4.60         2       11       5.50       0.02       0.80         50       55       9.60       0.02       1.40         2       23       8.00       0.06       1.30         2       28       3.70 | 2       170       11.00       0.06       1.70       10.00         50       260       15.00       0.06       3.00       10.00         2       95       4.00       0.01       1.60       14.00         50       275       6.00       0.01       2.80       14.00         2       145       4.60       0.17       2.50       14.00         50       365       6.30       0.17       5.60       14.00         2       255       5.80       0.06       2.50       18.20         50       650       8.20       0.06       4.70       18.20         50       650       8.20       0.06       4.70       18.20         2       265       21.50       0.25       3.30       12.70         50       690       29.50       0.25       3.30       12.70         2       125       16.40       0.17       3.00       5.67         50       375       20.50       0.17       4.90       5.67         2       195       6.00       0.08       2.40       17.50         50       560       8.00       0.08       4.60       17.5 | 2         170         11.00         0.06         1.70         10.00         15.45           50         260         15.00         0.06         3.00         10.00         17.33           2         95         4.00         0.01         1.60         14.00         23.75           50         275         6.00         0.01         2.80         14.00         45.83           2         145         4.60         0.17         2.50         14.00         31.52           50         365         6.30         0.17         5.60         14.00         57.94           2         255         5.80         0.06         2.50         18.20         43.97           50         650         8.20         0.06         4.70         18.20         79.27           2         265         21.50         0.25         3.30         12.70         12.33           50         690         29.50         0.25         4.70         12.70         23.39           2         125         16.40         0.17         3.00         5.67         7.62           50         375         20.50         0.17         4.90         5.67         18.29 | 2         170         11.00         0.06         1.70         10.00         15.45         2.78           50         260         15.00         0.06         3.00         10.00         17.33         2.94           2         95         4.00         0.01         1.60         14.00         23.75         3.45           50         275         6.00         0.01         2.80         14.00         45.83         4.79           2         145         4.60         0.17         2.50         14.00         31.52         3.97           50         365         6.30         0.17         5.60         14.00         57.94         5.38           2         255         5.80         0.06         2.50         18.20         43.97         4.69           50         650         8.20         0.06         4.70         18.20         79.27         6.30           2         265         21.50         0.25         3.30         12.70         12.33         2.48           50         690         29.50         0.25         4.70         12.70         23.39         3.42           2         125         16.40         0.17 | 2       170       11.00       0.06       1.70       10.00       15.45       2.78       1.16         50       260       15.00       0.06       3.00       10.00       17.33       2.94       1.54         2       95       4.00       0.01       1.60       14.00       23.75       3.45       0.38         50       275       6.00       0.01       2.80       14.00       45.83       4.79       0.48         2       145       4.60       0.17       2.50       14.00       31.52       3.97       0.41         50       365       6.30       0.17       5.60       14.00       57.94       5.38       0.48         2       255       5.80       0.06       2.50       18.20       43.97       4.69       0.47         50       650       8.20       0.06       4.70       18.20       79.27       6.30       0.58         2       265       21.50       0.25       3.30       12.70       12.33       2.48       2.40         50       690       29.50       0.25       4.70       12.70       23.39       3.42       2.81         2       125       1 | 2         170         11.00         0.06         1.70         10.00         15.45         2.78         1.16         4.29           50         260         15.00         0.06         3.00         10.00         17.33         2.94         1.54         8.02           2         95         4.00         0.01         1.60         14.00         23.75         3.45         0.38         -3.11           50         275         6.00         0.01         2.80         14.00         45.83         4.79         0.48         -2.78           2         145         4.60         0.17         2.50         14.00         31.52         3.97         0.41         -3.25           50         365         6.30         0.17         5.60         14.00         57.94         5.38         0.48         -3.20           2         255         5.80         0.06         2.50         18.20         43.97         4.69         0.47         -2.88           50         650         8.20         0.06         4.70         18.20         79.27         6.30         0.58         -1.83           2         265         21.50         0.25         3.30         12.70 <td>2         170         11.00         0.06         1.70         10.00         15.45         2.78         1.16         4.29         0.61           50         260         15.00         0.06         3.00         10.00         17.33         2.94         1.54         8.02         1.02           2         95         4.00         0.01         1.60         14.00         23.75         3.45         0.38         -3.11         0.46           50         275         6.00         0.01         2.80         14.00         45.83         4.79         0.48         -2.78         0.58           2         145         4.60         0.17         2.50         14.00         57.94         5.38         0.48         -3.20         0.63           50         365         6.30         0.17         5.60         14.00         57.94         5.38         0.48         -3.20         1.04           2         255         5.80         0.06         2.50         18.20         43.97         4.69         0.47         -2.88         0.53           50         650         8.20         0.06         4.70         18.20         79.27         6.30         0.58         -1.8</td> | 2         170         11.00         0.06         1.70         10.00         15.45         2.78         1.16         4.29         0.61           50         260         15.00         0.06         3.00         10.00         17.33         2.94         1.54         8.02         1.02           2         95         4.00         0.01         1.60         14.00         23.75         3.45         0.38         -3.11         0.46           50         275         6.00         0.01         2.80         14.00         45.83         4.79         0.48         -2.78         0.58           2         145         4.60         0.17         2.50         14.00         57.94         5.38         0.48         -3.20         0.63           50         365         6.30         0.17         5.60         14.00         57.94         5.38         0.48         -3.20         1.04           2         255         5.80         0.06         2.50         18.20         43.97         4.69         0.47         -2.88         0.53           50         650         8.20         0.06         4.70         18.20         79.27         6.30         0.58         -1.8 |

9

### CULVERT OUTLET SCOUR

|            | FL00D | Q                | VO    | <b>D</b> 50 | TW        | MO         | A     | YE   |            | HS    |       |         |
|------------|-------|------------------|-------|-------------|-----------|------------|-------|------|------------|-------|-------|---------|
| LOCATION   | FREQ  | CFS              | FPS   | <u>FT</u>   | <u>FT</u> | <u>F</u> T | SF    | FT   | F <u>R</u> | FT    | TW/YE | HS/D50  |
| GUMBOOT    | 2     | 142              | 5.80  | 0.21        | 1.50      | 15.00      | 24.48 | 3.50 | 0.55       | -1.34 | 0.43  | -6.37   |
| GUMBOOT    | 50    | 444              | 8.20  | 0.21        | 2.40      | 15.00      | 54.15 | 5.20 | 0.63       | -0.57 | 0.46  | -2.73   |
| ELK        | 2     | 71               | 3.90  | 0.17        | 1.00      | 13.90      | 18.21 | 3.02 | 0.40       | -2.58 | 0.33  | -15.15  |
| ELK        | 50    | 333              | 6.00  | 0.17        | 2.20      | 13.90      | 55.50 | 5.27 | 0.46       | -3.43 | 0.42  | -20.15  |
| CHESNIMUS  | 2     | 91               | 1.80  | 0.12        | 1.50      | 5,70       | 50.56 | 5,03 | 0.14       | -8.29 | 0.30  | -69.04  |
| CHESNIMUS  | 50    | 381              | 7.60  | 0.12        | 2.90      | 5.70       | 50.13 | 5.01 | 0.60       | -1.10 | 0.58  | -9.16   |
| CROW       | 2     | 135              | 3.90  | 0.04        | 3.00      | 12.80      | 34.62 | 4.16 | 0.34       | -4.31 | 0.72  | -107.85 |
| CROW       | 50    | 508              | 10.20 | 0.04        | 5.20      | 12.80      | 49.80 | 4.99 | 0.80       | 2.12  | 1.04  | 52.97   |
| MEACHAM T  | 2     | 75               | 4.80  | 0.06        | 1,60      | 12.80      | 15.63 | 2.80 | 0.51       | -1.42 | 0.57  | -23.71  |
| MEACHAM 1  | 50    | 375 <sup>-</sup> | 7.60  | 0.06        | 4.50      | 12.80      | 49.34 | 4.97 | 0.60       | -1.05 | 0.91  | -17.55  |
| MEACHAM 6  | 2     | 95               | 5.20  | 0.08        | 1.60      | 14.40      | 18.27 | 3.02 | 0.53       | -1.34 | 0.53  | -16.73  |
| MEACHAM 6  | 50    | 500              | 8.00  | 0.08        | 4.10      | 14.40      | 62.50 | 5.59 | 0.60       | -1.27 | 0.73  | -15.84  |
| MEACHAM 7  | 2     | 95               | 6.00  | 0.13        | 1.40      | 14.00      | 15.83 | 2.81 | 0.63       | -0.34 | 0.50  | -2.70   |
| MEACHAM 7  | 50    | 500              | 9.40  | 0.13        | 3.80      | 14.00      | 53.19 | 5.16 | 0.73       | 0.98  | 0.74  | 7.82    |
| MEACHAM 9  | 2     | 95               | 5.30  | 0.13        | 1.50      | 20.00      | 17.92 | 2.99 | 0.54       | -1.21 | 0.50  | -9.65   |
| MEACHAM 9  | 50    | 625              | 9.70  | 0.13        | 4.10      | 20.00      | 64,43 | 5.68 | 0.72       | 0.86  | 0.72  | 6.91    |
| SHEEP      | 2     | 20               | 9.00  | 0.25        | 0.70      | 7.00       | 2.22  | 1.05 | 1.54       | 1.38  | 0.66  | 5.51    |
| SHEEP      | 50    | 150              | 16.00 | 0.25        | 2.30      | 7.00       | 9.38  | 2.17 | 1.92       | 8.44  | 1.06  | 33.76   |
| CANYON 1   | 2     | 215              | 17.10 | 0.07        | 2.70      | 12.60      | 19.37 | 3.11 | 1.11       | 4.28  | 0.87  | 61.14   |
| CANYON I   | 50    | 675              | 15.60 | 0.07        | 4.80      | 12.60      | 43.27 | 4.65 | 1.27       | 8.81  | 1.03  | 125,81  |
| M CANYON   | 2     | 110              | 6.20  | 0.05        | 1.40      | 13.50      | 17.74 | 2.98 | 0.63       | -0.33 | 0.47  | -6.65   |
| M CANYON   | 50    | 350              | 8.60  | 0.05        | 2,50      | 13.50      | 40.70 | 4.51 | 0.71       | 0.63  | 0.55  | 12.62   |
| CANYON 3   | 2     | 105              | 6.50  | 0.09        | 2.00      | 9.50       | 16.15 | 2.84 | 0.68       | 0.09  | 0.70  | 1.05    |
| CANYON 3   | 50    | 345              | 9.00  | 0.09        | 3.60      | 9.50       | 38.33 | 4.38 | 0.76       | 1.22  | 0.82  | 13.56   |
| RUBY CREEK | 2     | 40               | 5.90  | 0.05        | 1.00      | 8.00       | 6.78  | 1.84 | 0.77       | 0.56  | 0.54  | 11.22   |
| RUBY CREEK | 50    | 165              | 8.50  | 0.05        | 2.10      | 8.00       | 19.41 | 3.12 | 0.85       | 1.75  | 0.67  | 35.02   |

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## CULVERT OUTLET SCOUR

|           | FLOOD | Q    | VO    | D50  | TW    | WO        | Α      | YΣ   |      | HS     |       |         |
|-----------|-------|------|-------|------|-------|-----------|--------|------|------|--------|-------|---------|
| LOCATION  | FREQ  | CFS  | FPS   | FT   | FT    | <u>FT</u> | \$F    | FT.  | FR   | FT     | TW/YE | HS/D50  |
|           | _     |      |       |      |       |           |        | 2.00 | 1.05 | 2.00   | 0.55  | 20 65   |
| BIG CREEK | 2     | 230  | 10.80 | 0.19 | 1.80  | 12.00     | 21.30  | 3.26 | 1.05 | 3.92   | 0.55  | 20.65   |
| BIG CREEK | 50    | 725  | 14.70 | 0.19 | 3.40  | 12.00     | 49.32  | 4.97 | 1.16 | 7.66   | 0.68  | 40.32   |
| INDIAN    | 2     | 185  | 9.60  | 0.15 | 1.60  | 12.00     | 19.27  | 3.10 | 0.96 | 2.83   | 0.52  | 18.85   |
| INDIAN    | 50    | 590  | 13.10 | 0.15 | 2.80  | 12.00     | 45.04  | 4.75 | 1.06 | 5.80   | 0.59  | 38.65   |
| GRAN 1    | 2     | 75   | 4.90  | 0.13 | 1.20  | 12.80     | 15.31  | 2.77 | 0.52 | -1.29  | 0.43  | -9.95   |
| GRAN I    | 50    | 290  | 7.20  | 0.13 | 2.30  | 12.80     | 40.28  | 4,49 | 0.60 | -0.98  | 0.51  | -7.53   |
| GRAN 2    | 2     | 75   | 4.70  | 0.25 | 1.20  | 13.10     | 15.96  | 2.82 | 0.49 | -1.55  | 0.42  | -6.21   |
| GRAN 2    | 50    | 290  | 7.10  | 0.25 | 2.20  | 13.10     | 40.85  | 4.52 | 0.59 | -1.13  | 0.49  | -4.53   |
| GRAN 3    | 2     | 95   | 6.20  | 0.17 | 2.20  | 13.20     | 15.32  | 2.77 | 0.66 | -0.10  | 0.79  | -0.61   |
| GRAN 3    | 50    | 350  | 9.00  | 0.17 | 4.20  | 13.20     | 38.89  | 4.41 | 0.76 | 1.19   | 0.95  | 7.01    |
| SUNFLO    | 2     | 135  | 7.00  | 0.21 | 1.10  | 17.30     | 19.29  | 3.11 | 0.70 | 0.30   | 0.35  | 1.44    |
| SUNFLO    | 50    | 485  | 10.80 | 0.21 | 2.10  | 17.30     | 44.91  | 4.74 | 0.87 | 3.04   | 0.44  | 14.49   |
| MARK'S    | 2     | 115  | 3.00  | 0.06 | 1.70  | 18.00     | 38.33  | 4.38 | 0.25 | -5.69  | 0.39  | -94.89  |
| MARK'S    | 50    | 600  | 4.80  | 0.06 | 3.70  | 18.00     | 125.00 | 7.91 | 0.30 | -9.09  | 0.47  | -151.51 |
| BROWN'S   | 2     | 100  | 4.20  | 0.04 | 1.80  | 12.60     | 23.81  | 3.45 | 0.40 | -2.91  | 0.52  | -69.40  |
| BROWN'S   | 50    | 415  | 6.10  | 0.04 | 3.60  | 12.60     | 68.03  | 5.83 | 0.45 | -4.08  | 0.62  | -97.07  |
| LOWE      | 2     | 440  | 10.50 | 0.13 | 2.60  | 20.50     | 41.90  | 4.58 | 0.86 | 2.80   | 0.57  | 21.57   |
| LOWE      | 50    | 1160 | 14.70 | 0.13 | 3.90  | 20.50     | 78.91  | 6.28 | 1.03 | 7.16   | 0.62  | 55.09   |
| POOP      | 2     | 10   | 8.00  | 0.17 | 0.40  | 4.00      | 1.25   | 0.79 | 1.59 | 1.09   | 0.51  | 6.43    |
| POOP      | 50    | 35   | 11.50 | 0.17 | 1.40  | 4.00      | 3.04   | 1.23 | 1.82 | 4.46   | 1.13  | 26.21   |
| PINE      | 2     | 230  | 13.70 | 0.13 | 1.70  | 7.50      | 16.79  | 2.90 | 1.42 | 6.79   | 0.59  | 54.29   |
| PINE      | 50    | 580  | 17.10 | 0.13 | 2.80  | 7.50      | 33.92  | 4.12 | 1.48 | 10.50  | 0.68  | 84.03   |
| HAIGHT    | 2     | 190  | 3.10  | 0.06 | 2.10  | 18.20     | 61.29  | 5,54 | 0.23 | -7.55  | 0.38  | -125.88 |
| HAIGHT    | 50    | 440  | 3.70  | 0.06 | 3, 10 | 18.20     | 118.92 | 7.71 | 0.23 | -10.46 | 0.40  | -174.30 |

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